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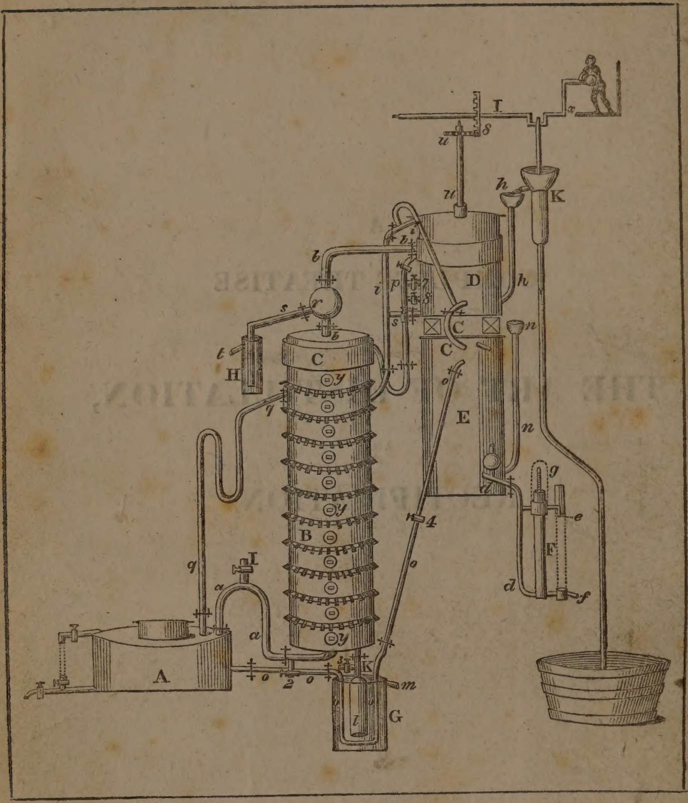
A
COMPLETE TREATISE
ON
THE ART OF DISTILLATION,
AND
RECTIFICATION.



Mr. Bluementhal's Apparatus for the Distillation of Wash.

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A

COMPLETE TREATISE

ON

The Art of Distillation;

Comprehending, in methodical order, the
MOST RECENT AND EXACT THEORETICAL
AND
PRACTICAL INSTRUCTIONS
FOR
Preparing Spirituous Liquors,
FROM
CORN, POTATOS, BEET-ROOTS, AND OTHER FARINACEOUS AND SUGARY VEGETABLES;
Which are also Useful to
MALTSTERS, BREWERS, AND VINEGAR-MAKERS;
ALSO THE WHOLE
ART OF RECTIFICATION,
In which is particularly treated the
NATURE OF ESSENTIAL OILS,
AS THE
INFLUENTIAL CAUSES OF THE TASTES AND FLAVOURS OF SPIRITS,
And of the most
Recent Discoveries and Improvements in that Art,
From the
FRENCH OF DUBRUNFAUT.
BY JOHN SHERIDAN.

To which is prefixed, the
DISTILLERS' PRACTICAL GUIDE,
BY PETER JONAS,
Entirely reviewed and augmented, with genuine Recipes for making
RUM, BRANDY, HOLLANDS, GIN,
AND ALL SORTS OF COMPOUNDS, CORDIALS, AND LIQUEURS.
FOURTH EDITION.

LONDON:
SHERWOOD, GILBERT, AND PIPER,
23, PATERNOSTER-ROW.
1830.

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PREFACE.

The success attending the previous editions of "THE DISTILLER'S GUIDE," by the late PETER JONAS, with the numerous recent improvements in the art, having rendered a new edition a desideratum, the Editor of the present work has availed himself of this opportunity, to collect all the most valuable information on this head, as nearly as possible into one view; especially all the processes that have been invented for accelerating the act of distillation, the saving of fuel, and the amelioration of the matter distilled; retaining only so much of the original author as has been confirmed by repeated trials, and sanctioned by subsequent experience.

It has been judiciously observed by an eminent Distiller, that "Distillation, though long practised, has not been carried to the degree of perfection that might reasonably have been expected. Nor will this appear surprising, if it be considered that the generality of Distillers have too long proceeded in the same beaten track, without even suspecting their art capable of improvements, or giving themselves any trouble to enquire into the *rationale* of the several processes they daily perform. They imagine the theory of distillation is very abstruse, and above the reach of common capacities; or at least that it requires a long and very assiduous study to comprehend it; and therefore content themselves with repeating the processes, without the least variation. This opinion, however ridiculous it may appear to those not acquainted with the general practice, has, I am satisfied, been the principal cause why distillation has not been carried to the height it would otherwise have been. I have therefore endeavoured to destroy this idle opinion, and shew the Distiller how he may proceed on rational principles, and direct his enquiries in such a manner as cannot fail of leading him to such discoveries as may be attended with advantage, both to himself and his country."

The art of the Distiller may be expressed in the form of a problem, the solution of which ought to command his most serious attention, thus: "To procure a degree of heat sufficient to boil the liquor he would distil, in the shortest time; to keep up this ebullition by an equal and unvarying heat as long as the operation continues; and by using the smallest possible quantity of combustible matter."

Some chemists flattered themselves with having discovered the means, extremely ingenious, for rectifying and distilling brandy by one and the same heat; but these means which they, through a silly prejudice, abandoned almost as soon as they had discovered them, have been resumed by our modern Distillers. They have completely changed the system of distillation. It is now our task to make known all those improvements that have been brought into the delicate operations of the art, especially those that contribute to hinder the goods from contracting the empyreumatic taste and the burning, by which the deleterious quality of the liquors have been contracted.

Among the most recent improvements made by the French in the art of distillation, much stress is laid upon what is called "the *precious* discovery of distillation *in vacuo*." For this purpose, M. Le Normand quotes a letter written at the commencement of 1812, by an inhabitant of the Isle of Re, to the Editor of the *Bibliotheque Physico Economique*.

"The new apparatuses for distillation present so many advantages, that one might be disposed to believe that nothing could be added to the art; but this would be a great error. We may distil without any combustible, especially in the south of France, during eight months in the year; and in the other four with so small a quantity of wood, that the expence is scarcely worth notice. The theory upon which this practice is founded, rests upon the fact, that all liquors distilled *in vacuo*, rise to the temperature of twelve degrees in Reaumur's thermometer. Nothing then remains to be done but to fix the vacuum above the still, and then the distillation will take place without heat, and as we may say without labour, from the month of March to October; during the other months, even brushwood will suffice. The success of the machine by which this is effected, cannot be questioned. It was constructed at Cherbourg, to convert salt water into fresh, for the supply of the garrison of the Isle of Pelée, situated a league from the land. One of the machines was embarked on board a vessel that belonged to the squadron of the unfortunate La Peyrouse; and drawings and memorials were addressed at the time to the Academy of Sciences, and to the minister of the marine: the whole was the work and invention of M. Meusnier, employed as captain of engineers at the siege of Mentz, at which place he was killed. Thus the Revolution has devoured this fine and beautiful machine, with many other rare inventions. It is much to be desired, that the Society for the Encouragement of the National Industry would propose a premium of forty thousand francs, for the best machine calculated to perform the act of distillation without fire, at any time when the temperature of the atmosphere shall not be lower than twelve degrees of Reaumur's thermometer. What an immense saving of fuel would result from this? Here the distilleries consume much more wood than individuals make use of for their daily concerns."

M. Le Normand, in his Preface to the Art of Distillation, remarks, that " the rapid improvements which the profound and continued study of the *physico chimiques* sciences have made within a few years in the art of distillation, especially in bringing the trade of French brandies to so high a degree of perfection, is such, that no neighbouring nation has arrived at. This commerce would have been exclusively *French*, but for the intervention of some unhappy events, not necessary to dwell upon here.

"It was a Frenchman who gave birth to the distillation of wines; and another who brought this art to perfection; or, to speak more precisely, who overturned all the systems practised before his time in substituting a new one. M. Arnaud de Villeneuve, the most distinguished chemist of the 13th century, created the art of distillation. In the first year of the 19th century, M. Edouard Adam, an obscure person, unacquainted with science, and ignorant of the art he intended to improve, made himself a new route, established a new system, and with a giant's pace, arrived at that point which the most sublime and profound geniuses had never been able to attain, after the continued labours of many centuries. If Arnaud de Villeneuve, Raymond Lully, the Portas, Lavoisier, Meusnier, or Fourcroy, had made such a discovery, one might have admired their genius without being surprised at their science. But that a man who had not even the first notions of the art in which he was engaged, and who had never had the least experience in manual operations; that he, who but a few years before had been seen selling linens and muslins, should rise as it were all at once, and at his first trial ascend to the acmé of the science of distillation with the rapidity of an eagle, penetrate its most hidden recesses, and perform that in an instant, which had employed the most profound geniuses more than six centuries, must appear extremely improbable; and our posterity may find some difficulty in giving credit to this prodigy.

"M. Adam had not learning sufficient to enable him to search the works of ancient authors. They wrote in a language with which he was unacquainted, and they were not to be found in the booksellers' shops of his day.

"I have not the presumption to suppose that I have performed the arduous task I had proposed. I am sensible of the insufficiency of my talents, and I have endeavoured to supply this want from the labours of others, in the work which I now present to all who interest themselves in the progress of the arts.

"In the description of the ART OF DISTILLATION of Brandy and Spirits, I have endeavoured to collect all that has been done; all that has been written upon the subject, which appeared proper to be known, for the purpose of bringing this important art to perfection. I have consulted every author who has treated of the Art of Distillation; not only among the moderns, but the ancients. Exclusive of those whose names I have quoted in my work, I have laid under contribution, Marazio, Spielman, Zozime de Panapolis, Gibel or Geber, Bazil Valentine, Glazer, Libavus, Berquin, Lemery, Brugnatelli, Fourcroy, Guyton de Morveau, and Hassenfratz. *Les Annales de Chimie, L'Encyclopédie Methodique, Le Journal de Physique, Les Annales des Arts et Manufactures,* have furnished me with much matter, I have frequently borrowed whole passages from M. le Compte Chaptal.

"Upon two different modes of distillation the whole art is founded, and by these the art of the Distiller is divided into two remarkable epochs. The first of these methods is to cause the evaporation (by means of a well-managed fire) of the mixture of two liquids; to receive the vapours that rise from the one and the other, into a vase in which they are condensed by the cold, and to collect the liquor thus condensed. The second mode, which differs essentially from the first, consists in causing the same evaporation of the mixture of two liquids, and to receive the vapours in a vessel, where, by the assistance of a degree of caloric prudently administered, the whole undergoes a complete analysis, with a separation into two distinct parts, whereof the one being *spirituous*, is collected on one side, after having been condensed by the cold in a vase appropriated to this kind of operation; the other *aqueous*, which is condensed during the analysis itself, and is received separately.

"The first mode of distillation was generally followed to the end of the eighteenth century; the second commenced with the nineteenth, and has since gradually taken place of all the former processes.

"For this reason I have divided this work into two parts. In the first I have treated upon every subject that had any relation to the first epoch; I have traced the history of the distiller's art from the most remote periods up to the revolution effected by the discovery of Edouard Adam.

"The second part is entirely devoted to the description of the modern processes. Those of Adam, Laurent Solimani, Isaac Berard, Menard, Pierre Alégre, J. B. Carbonel d'Aix, I have described with much detail. I have shown the changes, the ameliorations, and the improvements of which these processes are susceptible, or those which they have undergone in the hands of these professors. I have also noticed the modifications introduced into the apparatus of distillation by Jean Jordana, a Spaniard.

"Distillation *in vacuo* has occupied much attention among the learned; one chapter is devoted to an illustration of their researches.

"The art of aereometry, that part so precious in the commerce of brandies, and which at present is but in its infancy, finds a place in my second volume. With the view of bringing it to perfection, I have published all the information that can be found. I have described the aereometer of M. Descroisilles, the alcoholometre of M. Alégre, jun., an aereometer of my own invention, and three new instruments as yet undescribed.

"The art of gauging casks, &c. is treated with considerable detail. I have noticed a very simple instrument of my own invention, which affords considerable facility in the operation of gauging.

"I have added advice to Distillers upon the choice of wines proper for distillation; the description of the means which the Distiller should use in the exercise of his art, in a manner the most advantageous; and the description of a complete distillery forms several chapters, which terminate the second part. Lastly, the Vocabulary belonging to the art of distillation is prefixed to the first volume.

"The innumerable difficulties attending a plan of such magnitude as that I had proposed to myself, have not escaped me: I have repeatedly felt my insufficiency, and should have abandoned my project, had it not been for the salutary advice of several distinguished *savans*, particularly M. le Compte Chaptal, who guided my first steps in the study of chemistry.

"Encouraged by the favourable reception with which my first *Memoires sur L'Art de la Distillation* were received, I presume upon the indulgence of the reader for the work I now present him. If it should be admitted that I may be useful in furnishing Distillers with the means of going beyond the present bounds of their art, I shall be sufficiently recompensed for the labour and the painful researches I have engaged in, to place before their eyes in these volumes, all that appeared to me as being useful in obtaining the desired end."

N.B. Edouard Adam, alluded to in this work, was by birth a Norman, but afterwards became an inhabitant of Nismes, in the department of Gard. He changed the system of distillation, by adopting the apparatus made use of by Woulfe for the distillation of wines, and by Count Rumford's economical method of procuring heat. Thus the revolution that this art has undergone in France, has been ascribed to Edouard Adam.

M. Le Normand recommends the example of England to the imitation of his countrymen, in applying the arts to the promotion of their commerce. "Let us," says he, "imitate that neighbouring and rival nation, whose prosperity is wholly founded upon its commerce. There the arts are protected in a special manner by a strong and powerful government, which never ceases to encourage them by every means in its power. The English are well convinced that the arts, connected with industry and commerce, are inexhaustible mines which they can explore without expence, and which offer a continual support to the finances of the state, after having spread abundance and happiness through every class of society."

In England, however, in the vessels used for distillation, many capital improvements have been recently made, in consequence of modern discoveries respecting bodies in their aëriform state. It was common with the earlier chemists to make a small hole in the upper part of their retorts, through which the elastic vapours might escape, which otherwise would have burst the vessels. By this they lost a very considerable part of their products. But as it is requisite sometimes to obtain separately the condensable fluid that comes over, and the gases that are, and are not soluble in water, for this purpose a series of receivers, more or less in number, as the case may require, is generally employed, as what is called Woulfe's apparatus, &c. Another contrivance to prevent retrograde pressure is that of Mr. Pepys; and the ingenious modification of Mr. Woulfe's apparatus by Mr. Knight.

In the present work, we begin by describing the apparatus used for distilling in this and other parts of Europe. Secondly, we give the description of a distillery, and general directions to the Distiller and Rectifier, with directions for malting, fermentation, and rectification; to which are added a great variety of recipes for producing different spirits, compounds, cordials, &c. according to the best and most approved processes; with general rules for the distillation of simple waters, the laws affecting distillers for home consumption, and a complete set of tables, exhibiting the exact weight of spirituous liquors, and also of water and vinegar: the whole interspersed with the recent improvements adopted on the Continent, particularly in France and Holland, from chemical discoveries, new machinery, &c. &c.

In fine, no means of information have been neglected, and no pains spared, to acquire knowledge of the subject from the most authentic sources: hence the compiler is induced to submit the result of his labours with confidence to the eye of a discerning and candid public.

THE

DISTILLER'S GUIDE.

CHAP. I.

DISTILLATION BY VARIOUS PROCESSES.

DISTILLATION has been defined, the vaporization and subsequent condensation of a liquid, by means of an alembic, or still, or refrigeratory, or of a retort and a receiver. The old distinctions of *distillatio per latus, per ascensum*, are now discarded.

The late celebrated Mr. Watt, having ascertained that liquids boiled *in vacuo* at much lower temperatures than under the pressure of the atmosphere, applied this fact to distillation; but he seems, according to Dr. Black's report of the experiment, to have found no economy of fuel in this elegant process; for the latent heat of the vapour raised *in vacuo*, appeared to be considerably greater than that raised in ordinary circumstances. Mr. Henry Tritton has lately contrived a very simple apparatus for performing this operation *in vacuo;* and though no saving of fuel should be made, yet a superior flavour may be secured to the distilled spirits and essential oils, in consequence of the moderation of the heat.

The still is of the common form; but instead of being placed immediately over a fire, it is immersed in a vessel containing hot water. The pipe from the capital bends down, and terminates in a cylinder or barrel of metal plunged in a cistern of cold liquid. From the bottom of this barrel a pipe proceeds to another, of somewhat larger dimensions, which is surrounded with cold water, and furnished at its top with an exhausting syringe.

The pipe at the bottom of the still, for emptying it, and that from the bottom of each barrel, are provided with stop-cocks. Hence, on exhausting the air, the liquid will distil rapidly, when the body of the alembic is surrounded with boiling water. When it is wished to withdraw a portion of the distilled liquor, the stop-cock at the bottom of the first receiver is shut; so that on opening that at the second, in order to empty it, the vacuum is maintained in the still. It is evident, that the first receiver may be surrounded with a portion of the liquid to be distilled.

M. M. Adam and Duportal have substituted for the redistillations used in converting wine or beer into alcohol, a single process of great elegance. From the capital of the still, a tube is led into a large copper recipient. This is joined by a second tube to a second recipient, through a series of four vessels, arranged like a Woulfe's apparatus. The last vessel communicates with a worm of the first refrigeratory. Thus the body of the still, and the two recipients nearest it, are charged with the wine, or fermented liquor. When ebullition takes place in the still, the vapour issuing from it soon communicates the boiling temperature to the liquor in the two recipients. From these, the volatilized alcohol will rise, and pass into the third vessel, which is empty.

After imparting a certain heat to it, a portion of the finer, or less condensed spirit, will pass into the fourth, and from thence, in a little time, into the worm of the first refrigeratory. The wine round the worm will likewise acquire heat, but more slowly. The vapour which, in that event, may pass uncondensed into the first worm, is conducted into a second, surrounded with cold water. Whenever the still is worked off, it is replenished by a stop-cock from the nearest recipient, which in its turn is filled from the second, and the second from the first worm tub. It is evident from this arrangement, that by keeping the third and fourth recipients at a certain temperature, we may cause alcohol, of any degree or lightness, to form directly at the remote extremity of the apparatus. The utmost economy of fuel and time is also secured, and a better flavoured spirit is obtained.

The *arriere gout* of bad spirit can scarcely be destroyed by infusion with charcoal and redistillation. In this mode of operation, the taste and smell are excellent from the first.

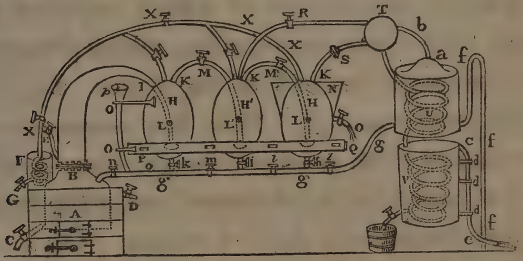
Several stills on the above principle have been constructed at Glasgow, for the West India distillers, and have been found extremely advantageous; but the excise laws do not permit their employment in the home trade.

The apparatus for distilling, upon which all the recent improvements in France are founded, is that of M. Adam, of which an excellent description may be found by M. Chaptal, inserted in the *Nouveau Cours Complet d'Agriculture, Theoretique et Pratique, à l'article, Distillation.* In a furnace, situated in one corner of the distillery, is placed a still, built into the masonry. The head is in the form of a dome, solidly fixed with the cucurbite. From the centre of this dome, a tube ascends, as thick as a man's arm; and this runs into the first vessel, placed on one side of the still, which is fixed upon strong joists. From this vessel issues a second tube, similar to the first, but in the form of an arch, which enters another vessel, also resembling the first, which communicates with a third in the same manner.

In this apparatus, thus simplified, there are several points to be considered: in the first place, all the vessels fixed upon the joists are made in the form of an egg, and have their two ends placed vertically. Secondly, that the entering tubes, viz. those which proceed from the still to the first egg, and from the first into the second, &c., have their extremities in the bottom of each egg, and there form something like the head of a garden or watering pot, pierced with several holes. Thirdly, the last of these eggs, when there are but three, and sometimes the two last when there are four, are furnished with a cooler in their upper part; and this is always filled with water whilst the distillation is going on. These vessels, with their *refrigerator*, are called condensers.

Every distiller does not use condensers; the majority look upon them as useless, when they only wish to obtain *trois six*, three six; however, they have all the rest of the apparatus complete; and as these eggs communicate one with another, and each separately with the first worm, they may be used as condensers at pleasure it is only necessary to turn or stop one of the cocks.

At the extremity of these eggs a large tub is placed, the interior of which contains a large worm constructed of tin, which plunges into the wine instead of the water, and is hermetically sealed. This first worm communicates with a second longer than itself, and enters a large tub placed under the first, which is entirely full of water. On one side, and under this lower tub, a large space is dug in the earth, and built round with stone, which the French distillers call a *tampot;* this serves as a magazine for their wine previous to distillation, which may be pumped into the upper tub. All the eggs, as well as the still, communicate with the upper tub through tubes placed between the lower part of the eggs and the still. There are besides lateral tubes, which run from the upper part of the eggs to the orifice of the worm in the upper tub; there are other tubes proceeding from the upper part of each of the vessels, even from the still, which enter a small worm immerged in a little tub upon the furnace by the side of the still. The mechanism of the distillation is not less curious than the apparatus.



Explanation of the Egg Plate.

A, is the furnace in which the still B is built; of this the dome or head only is to be seen; the punctuated lines indicate the form masked by the building. C is the tube, furnished with a cock on the outside of the furnace, communicating with the bottom of the still, for the purpose of discharging the alembic and the eggs. The small tube D, also provided with a cock, serves to point out when the still is full within two-thirds of its height. The little tube E, also proceeds from the head of the still with its cock, which communicates with the long tube X X X X, which runs from the last egg, that is to say, from that at the greatest distance from the still, and communicates with the little worm which is plunged in the little tub F, placed under the furnace to prove the vapours contained in each of the distillatory vases. This little worm has the cock G at its lower orifice. H H H, are a series of distillatory vessels, or condensers, in the shape of eggs, solidly fixed up on the timber work P Q, and in succession with each other on the side of the still. One side of this timber work rests upon the furnace, and the other upon the stone work which supports the upper tub. Our plate represents only three eggs, though the number may be augmented at pleasure. It was the opinion of M. Adam, that the greater the number of eggs, the better the rectification would be carried on.

The still communicates with the first egg by the tube I, which rises from the centre of the head or dome, and descends to the bottom of the egg, where it enlarges into the form of the rose of a garden watering-pot pierced with a number of holes. It must be understood that this tube is soldered to the egg at its entrance, to prevent any other issue of the vapours but by the way intended. The first egg communicates with the second, this with the third, and so on to the last, by means of the tube M, which is soldered to the first egg at the point K, and proceeds to the bottom of the following, where it enlarges in the form of a watering-pot, as in the first.

The last egg is furnished with the cooler N, by means of which the superior part of the egg where the vapours are collected is encircled with water to commence the refrigeration. This cooler is supplied with a cock O, to let out the water when it gets too warm. Every condenser is furnished with a cock like this; or otherwise their upper parts are plunged in the common tub full of water. This tub or bag, often made of copper, has the form of a parrallelipede. The tube R communicates from the second egg with the worm, which is generally used with two eggs, sufficient to obtain brandy at eighteen degrees, when they close the cock M, which communicates with the second and third egg, and they open the cock R to establish the communication with the worm.

The pipe S communicates between the third egg and the worm. When three eggs are used, they operate as we have indicated; they open the cocks M and S, and stop the cock R. The same proceeding is observed when the greatest number of eggs are employed. Each of these has a tube that communicates with the worm, and all these are soldered to the spherical T, in which the vapours from each egg are deposited, to be conveyed from thence into the worm in the tub U.

U is a tub hermetically closed, which contains the principal worm; this is full of wine, heated by the passage of the hot vapours from the last; it is also surmounted with the dome a, from whence proceeds the pipe b, that serves to contain the alcoholic vapours that escape from the tube last mentioned, from the vessel T, or from any of the eggs, or the still, to convey them thence into the worm.

V is a large tub under the first, and which encloses the second worm, but is much longer than the other. It is full of water, always kept cold; but disgorges itself through the pipe c on the outside of the vessel, against which it is supported by the three iron bars d d d.

We have not thought it necessary to represent the stone cavity used as a store-house for the wines designed for distillation, which wines may be raised into the tub U by means of a pump managed by one man; the conducting pipe of this, marked f f f, discharges itself near the bottom of the tub U.

g g g is the pipe of communication belonging to the still and the eggs; h i k, are cocks to establish or intercept the communication of the eggs with the conducting pipe g; *l l* m n, are cocks for continuing or interrupting the communication between each egg, and the still to discharge it, or with the condensing vessel for the purpose of filling it; o o o, is the pipe through which the brandy or the feints are conveyed by means of the tun, *p*, when they wish to charge the still or the eggs. It is soldered to the pipe g, into which it discharges itself, and is consolidated with the rest of the apparatus by two iron bars, one of which is nailed to the timber work P Q, whilst the other is attached to the first egg. This pipe is called *Corne d'Abondance*, or Horn of Plenty.

All the apparatus of the French distilleries which have been encouraged by patents, have been constructed according to the principles of this now described, or those analogous to them.

Many of them, it must be allowed, are but modifications of this; others are imitations of Solimani's model; and others again, imitations of M. Berard's; consequently all the distilleries that have given up the old processes for the new, have more or less adopted the principles of those chemists to whom we have already referred.

In the working of the still last described, they first close the lower cocks that communicate with the grand tube connected with the eggs. They open those of the conducting tube; then the wine contained in the tun escapes and settles in the still. During this time a labourer pumps, to replace the wine in the tun that has escaped by the pipe. They know that the still is sufficiently charged when the wine flows through the little cock adapted to it. When the charging is completed they stop this cock, as well as that belonging to the conducting pipe nearest the still. They then open the cock that communicates with the first egg, and keep it so till the wine flows through a tube placed nearly at half of the height of the egg, and then close the small pipe and the large cock that communicates with the egg, and that of the conductor. They proceed the same way with the other eggs, excepting the condensers, when there are any, into which they do not put any liquor whatever; but having filled their coolers with water, they close all the lower cocks, and open the upper ones to afford a free passage to the vapours; and during this time a fire is kindled in the stove. When the wine is sufficiently heated to disengage the alcoholic vapours, they collect these in the vacant part of the cucurbite running through the first tube; these are then carried down to the lower part of the first egg, from whence they issue through an infinity of small holes. The globules are compelled to traverse the liquid to ascend to the upper part of the egg; but it is necessary to observe, that the vapours that issue from the still are not purely alcoholic, but mixed with many watery particles. In visiting the vacant part of the egg, the watery part mixes with the wine, with which it has much affinity, whilst the spirituous parts accumulating in the upper part of the first egg, pass from that into the second and third, and after having traversed them all, settle in the upper worm, where they condense, and finish the cooling in the second worm. The liquor comes out cold from the lower orifice of the second worm, and is received into the vessel destined to that purpose. The vapours are passed through all the condensers, or only a part of them, accordingly as the operator wishes to have the alcohol more or less pure.

In order that the alcohol should not evaporate in passing from the worm into the hogshead, &c., and that the stream of the liquor may be seen at the same time, a pipe is attached to the extremity of the worm, communicating with the bung-hole of the hogshead. The terminating part of this pipe is formed of glass, through which the liquid may be distinctly seen. This instrument is called the *lantern.*

The alcoholic vapour that passes into the first egg in a state of ebullition, and deposits a part of its caloric there, contributes to the ebullition of the wine in this vessel, and disposes the liquor to distillation; still the wine is not carried to that degree of heat necessary for this operation, till a considerable time after the distillation has commenced from the still. It is then less pure than when it was first put in; it is charged with watery vapours that have not been able to combine with it. Two different products are then drawn up to the superior part of the first egg; that is to say, the brandy that came out of the still, but disengaged from its watery parts, and the brandy produced from the liquor of the first egg. This being charged with more water than the first, weakens the first liquor; and nothing is obtained from this mixture beyond a brandy of fourteen or sixteen degrees.

In the passage of the liquor into the second egg, the same phenomenon takes place; but here the aqueous vapours mingle with the wine; and the alcoholic vapours rise from the second egg with a less quantity of water than those of the first, and the brandy flows at eighteen degrees.

When it is the object to extract brandy only at Holland proof, or eighteen degrees, the still and two eggs are sufficient. The cock which transfers the vapours of the second egg to the third, is then closed, and that which communicates the vapours of the second egg to the highest worm, or the first worm, is then opened. The products of the still are still taken, till it is perceived that the liquor is diminished in strength. The first hogshead is then removed, and replaced with another, to receive what are called the *repasses*, or feints, in order to redistil them, and continue the operation till the still no longer yields any spirit.

To know the precise moment when the distillation should be stopped, they open the first small cock on the side, which conducts to the little worm placed upon the stove, and close that which conveys the vapours from the still into the first egg. The vapours being condensed in the small worm, the liquor is received in a glass: being thrown upon the head of the still, a piece of paper may be lighted by this hot liquor, which, if it does not burn, it is thought proper that the distillation should be stopped. French distillers use the same process, in order to judge of the strength of the vapours disengaged from the eggs employed. When these, which proceed from the still, no longer contain any alcohol, the fire is extinguished, and they let out the residuum, which is become useless; and afterwards do the same with respect to the eggs. But if, on the contrary, alcohol is still found, it is passed from the egg into the cucurbite, which is charged as at first, and they finish at a convenient time, by adding the feints, or some wine, if it should be necessary. The eggs are then charged with the wine found in the first worm, which has already been heated in the first distillation ; this is a great saving of fuel, and hastens the operation.

In small distilleries, where only three eggs are used, when they would charge the eggs or the alembic with brandy or feints, they may distil three six, by charging one or two eggs, or the alembic with brandy, or with the feints. They use a large tube, which being fixed between the still and the first egg, communicates with another, used to charge the alembic with wine ; a funnel is introduced into the orifice of this tube, and by this means, and by closing the communication with all the rest, the liquor is conveyed into the vessel intended, and the cocks are also closed. The large tube here alluded to, is the *Corne d'Abondance*, or Horn of Plenty.

Another point is very essential to be attended to : it has been said, that the tun filled with wine, in which the first worm is placed, was hermetically closed; but notwithstanding this, it receives the alcoholic vapours, whilst very warm, and the wine is heated by them, and consequently, as well as the eggs, disengaged from those vapours. To retain them, the tun is completely covered; but in order that they may not force the cover, and thus cause the loss of the goods, the cover is made in the shape of a dome, surmounted by a small tube, which either conducts them into the worm, or into the eggs, or the still. Observing these precautions, no loss can attend the process of distillation.

To afford a complete idea of the improvements we have endeavoured to introduce by this mode of distillation, we must remark, that, with the aid of the pump, the wine is conveyed from the *tampot* into the tun, and is discharged at the bottom of this vessel. The cold wine, heavier than the warm, always occupies the lowest place, and expels the warm liquor, which serves to charge the still or the eggs. This construction has another advantage, as the alcoholic vapours that escape the tun, can find no other issue but that through the tube, which carries them into the worm or into the eggs.

CHAP. II.

THE APPARATUS USED FOR DISTILLATION IN GREAT BRITAIN.

WITH respect to vessels generally used in this country, when the condensed vapours are obtained in the liquid form, the shape and situation of them are very different. The vapour should be kept completely in its elastic form, to a certain height. The neck of the vessel should then turn by a sharp curve on an elbow, so that the substance after condensation into the liquid form, may, by its gravity, descend as quickly as possible. The height of the elbow above the point where the heat is applied, should be only sufficient to guard against the mass below, getting over the neck by boiling. When the neck of the lower vessel is liable to be long, it should be defended either by being polished, or clothed, to prevent the escape of heat, in order to allow the vapour to be carried over into the descending part before it condenses. The vessel from which the vapour rises, when of a large size, and used for distilling simple liquids, is called a *still.* Those used for experiments in a small way, and also for distilling acids, ammonia, ether, &c. are called *retorts;* the vessel that receives the distilled matter being called a *receiver.*

The retort is the most simple of the distilling apparatus; but it can only be employed when the vapour is easily condensable, or when little heat is applied. The most simple of this variety, is the *alembic.* It consists of a lower vessel, terminating in a narrow neck, which, with the substance to be distilled, is applied to the fire. At a certain height, depending on the nature of the substance, a spacious vessel is placed upon the neck, which is exposed to the air, or kept cool by a supply of cold water. If exposed to the air, it should be painted of japanned black. Round the bottom of the interior is a projecting channel, to receive the liquid rising from the condensation of the vapour that runs down the sides of the open vessel, in preference to falling back into the still. From this channel the liquid descends into a receiver by a pipe placed at a certain angle. This apparatus, when designed for small experiments, is made of glass, but more frequently of metal. It is at present not often used, the condensation by the worm-tub being much more effectual. A retort, in fact, is a kind of bottle with a long neck, so bent that it makes with the belly an angle of about sixty degrees. The upper part of the retort is the arch or roof, and the bent part is the neck.

When the worm-tub is employed, the still requires such a shape, that the greatest possible surface may be exposed to the fire. Its shape is then that of a frustrum of a cone. The neck should be of such width as to convey the vapour away as fast as formed. The height of the neck is regulated by the nature of the substance operated upon: if it is mucilaginous, the neck should be longer, to prevent its boiling over; and the exterior of the lower part should be polished, to prevent the escape of heat; the descending part painted black, and its end inserted into the neck of the worm.

The worm-tub is a wooden vessel, about six or eight times the capacity of the still; the length of the diameter should be about ten to seven. The worm consists of a spiral tube, which enters on one side of the tub at the top: it then passes spirally, in about six or eight convolutions to the bottom, where it comes out of the side, in order to discharge the liquid arising from the vapour condensed within it by the agency of the cold water with which the tub is filled. The water is constantly changing, by the warm water running away from the top, whilst a supply of fresh water comes in at the bottom. The section of the tube being a circle, its capacity should not be less than one fifth of that of the still; the diameter of the ends of the tube being about three to one. The object is not merely to effect a condensation, but to cool the liquid; the means of performing this will not always depend upon the relative sizes of the vessel, but must be governed by the quantity of vapour supplied in a given time, and the supply of cold water.

The vessel that incloses the substances to be distilled, is called an *alembic.* It is very dangerous to use one that is not tinned, as the liquor would assume a deadly quality. An alembic is composed of two or three parts, according to which the distillation is carried on by fire or by the *Balnea Mariæ ;* in the first the bottom of the alembic is in close contact with the fire; but in the latter, its lower part is placed in another vessel larger than itself, which being filled with water, this acts as a medium between that and the fire. The alembic, properly speaking, is composed of two parts, the cucurbite, and the head; but though the form of the latter may vary according to the system of operations adopted, its use is always the same, namely, to contain the matter intended for distillation.

When the cucurbite is large and spacious, as it must be in great distilleries, then it is necessary to fix it in the masonry of the copper. In this case, it is difficult to clear it of the phlegm or the residue of the distillation, even with the aid of a syphon, according to the practice of the ancients. However, this is now best remedied by a cock on one side of the vessel, near the bottom, that must be set running when the alembic is discharged, or when it is necessary to clean it. The size of the cucurbite varies in different countries. Many distillers, to augment their products, or to ameliorate their quality, add a cooler to the head of the still; however, the observations continually made in large distilleries, have sufficiently proved that coolers, if not pernicious in the distillation of brandies, were useless. Consequently the use of them was dropped, as was also the pipe, or tube, called the Blackamore's-head. But whether the still head be conical or otherwise, its uses are always the same, viz. to receive the vapours caused by the ebullition of the liquid, and to transmit them through the different tubes that surround the still-head, and form a part of it. These tubes present the figure of a truncated cone, the smallest diameter of which is the most distant from the head.

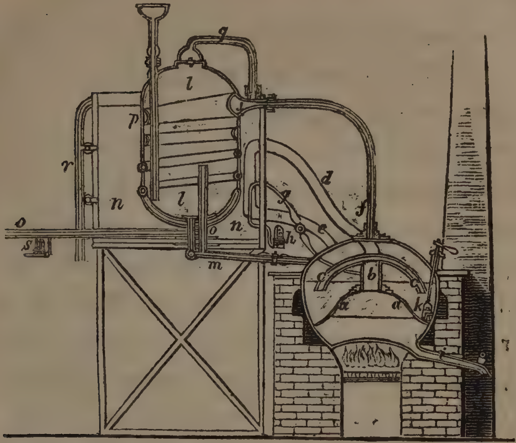
Every vessel composed of copper in a distillery, ought to be well tinned, and continually examined, as otherwise a deterioration will inevitably occur. The acid of wine as well as that of ardent spirits, corroding the copper, will form verdigris, which will be mixed and distilled with the liquor.

Upon the English Stills, and their recent Improvement.

In describing the stills of this country, it is necessary to observe, that all distillatory vessels are either *alembics* or *retorts;* the former consists of an inferior vessel called a *cucurbite*, designed to contain the matter to be examined, and having an upper part fixed to it, called the *capital*, or head. In this last, the vapours are condensed by the contact of the surrounding air, or, in other cases, by the assistance of cold water enclosing the head in a vessel called the *refrigeratory*, or cooler. From the lower part of the *capital*, or *still-head*, a tube proceeds, called the nose, nosel, beak, or spout, through which the vapours, after condensation, are made to flow into a vessel called the *receiver*, which has usually been spherical. Receivers have had several names, according to their figure, being called mattrasses, balloons, &c. Retorts, as before observed, are a kind of bottle, formed of glass, earthenware, or metal, the bottom spherical, and the upper part gradually diminishing into a neck, which is turned on one side. This machinery has been generally known by the name of *Woulfe's apparatus.* Something of the same kind, however, was invented by Glauber, as early as the year 1655; but the chief improvement upon Woulfe's apparatus consists in filling the lateral vessels with water, into which the inventor dips the extremity of each tube, bringing into it the uncondensed part of the vapour, and saving a vast quantity of product that had formerly been wasted.

There have been various modes of applying heat in distillation, depending upon the nature of the apparatus employed, as well as upon the substance to be distilled. The common still being formed of metal, is immediately exposed to the naked fire, since from its tenacity, and its property of conducting heat with facility, it is not liable to crack, which is not the case with glass or earthen-ware. The still is heated various ways, the most common of which has been by the *sand-bath*, a vessel of iron filled with fine dry sand. The retort, or other vessel, is imbedded in the sand previous to the application of the fire: the inferior conducting power of the sand does not allow the heat to approach the retort, but in that gradual way that ensures its safety from cracking, and thus the heat is more uniform.

Amongst the best and most recent improvements in the stills of this country, that for which a patent was obtained by Mr. Wright, engineer, of Kent-road, in 1821, seems of much promise.



This still, represented in the cut, is made of metal, as usual, but having one internal division, *a a*, this forms the still into two compartments; these are both charged with wash, or other liquor intended for distillation. The still being heated by the furnace below, the vapour from the lower compartment will be driven through the tube *b*, and descend by the bent pipes, *c c*, into the wash of the upper compartment; or from the tube *b*, without the bent pipe, the vapour may be dispersed above the surface of the liquor within the still, by the intervention of a plate placed over the tube *b*, by a pipe *d*, up to the vessel of water, and descend again by the pipe *e*, into the upper compartment of the still; by which means a partial condensation will have been effected of the grosser vapours which have arisen from the lower compartments, and the lighter or uncondensed vapour will pass off through the perpendicular pipe *f*, to the condensing apparatus, where it finally becomes spirit. The heat of the furnace being continued, the vapour from the upper compartment of the still will also be driven off, and pass through the pipe *f*, to the condensing apparatus. A small pipe, *g*, with a stop-cock, is inserted into the tube *b*, and carried through the vessel of water, by which a small quantity of the vapour from the lower part of the still may be admitted into the glass vessel *h*, for the purpose of ascertaining the quality of the vapour.

When the spirit is out of the lower compartment of the still, and the upper compartment reduced to the gravity intended, the spent liquor below is to be drawn off through the cock *i*, after which the valve *k* may be opened, to admit the liquor from the upper to the lower part of the still; and the succeeding charge is drawn from the cistern *l*, through the pipe *m*, to the upper part of the still.

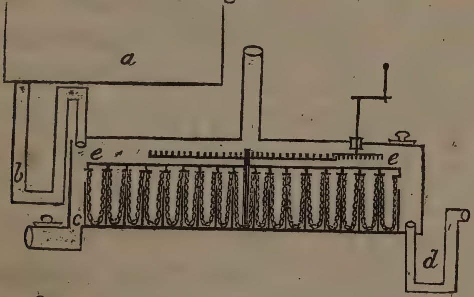
The condensing apparatus consists of two cisterns, placed one within the other; the inner one, *l*, should be made of copper, and is filled with wash or other liquor intended for subsequent distillation, by means of the pipe and funnel *j*. This vessel should at least contain two charges for the upper compartment of the still. The outer vessel, *n n*, may be made of wood, and must be charged with water circumscribing the inner vessel. When the vessel is attached to other stills, the outer vessel, *n n*, may be dispensed with, and the pipe *o o* attached, which must communicate with another condenser.

The vapour passing from the still through the pipe *f*, as above described, proceeds to the spiral condensing pipe *p*, which passes several times round the vessel *l*, and the vapour being cooled and condensed in its progress, finally collects in the form of spirit, and is drawn off through the pipe *o*; *q* is a pipe inserted into the head of the vessel *l*, with a light valve opening upwards, for admitting any vapour into the condenser *p*, which might arise from *l*; but this at the same time prevents the passage of any vapour from the still through the pipe *f*. A waste pipe, *r*, is attached to the cistern *n*, to carry off the surplus water.

The parts of this apparatus claimed as original, are, "a vessel to contain wash or other liquid in the progress of distilling, surrounded by a cavity for condensing the water from the still." The apparatus shewn at *h* and *s*, are glass vessels containing a number of graduated bubbles of known gravity, which being put into a glass vessel, into which a portion of the spirit passes from the still, according to the number of bubbles afloat, denote the levity of the spirit, by their colour or shape. With the assistance of a thermometer, the strength is ascertained. Here it is not necessary to describe the well known graduated bubble.

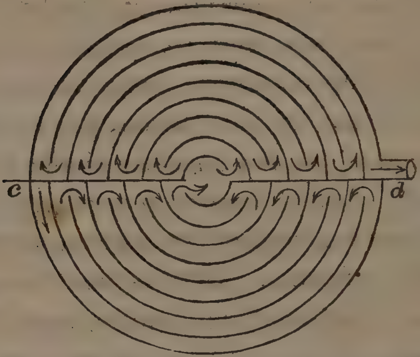
Another improvement made by Sir Anthony Perrier, of the city of Cork, is to cause the liquid operated upon in the process of distillation, to flow gradually over the heated surface of the boiler, whilst it continues to give out its spirituous evaporation. The quantity of liquid allowed to be acted upon, or to pass through the still in a given time, and also its velocity, is regulated by the circuitous route in which it proceeds, and by that means the complete operation of the fire upon the whole fluid is insured, without impeding or clogging the spirituous evaporation by aqueous or empyreumatic vapours. By this construction of a still, a continued and uninterrupted distillation, boiling, or evaporation, is carried on as long as the supply of liquid is furnished, and the fire kept up.

Fig. 1.



In fig. 1, is a view in profile of the section of a still or boiler, made on the improved principle; of copper, or any other suitable material; and fig. 2, is a plan of

Fig. 2.



the same. The bottom of this boiler is divided by concentric partitions, which stand up as shewn in fig. 1, sufficiently high to prevent the liquor from boiling over. These partitions have openings from one to another, at opposite sides, so as to ~~make the course~~ a sort of a labyrinth: *a*, is a reservoir of liquor prepared for the operation; *b*, is a pipe or tube descending from the reservoir, and conducting the liquor to that part of the boiler marked *c*, which is the commencement of the race. From hence the liquor flows through the channels, as shewn by the arrows, progressively traversing the whole surface of the bottom, so that the full effect of the fire is exerted upon small portions of the liquid, which causes the evaporation to proceed with great rapidity. The residue of the liquor then passes off by the discharge pipe *d*, contrived to slide for the purpose of regulating the quantity and depth of the fluid intended for the still; and this pipe should be in such proportion to the admission pipe, as to cause the perfect distillation of the liquor in its passage to the regulating tube.

The spirit which rises in the head of this improved still, will be found much stronger and purer than that obtained from stills of the ordinary construction, where the spirituous vapour is much mixed with aqueous matter and other impurities. The channels may be extended to any length required, over a bottom of any dimensions, by contracting their breadth.

Stills upon this principle may be made of all sizes and shapes, round, square, or otherwise; and the partitions may be placed in concentric or eccentric circles, with opening on their sides, at such distances as shall cause the liquor to flow over the most extended surface of bottom; or, the still may be square, with angular partitions ranged as a labyrinth, or in any other manner, so as to cause the run of the liquor to be greatly extended over the surface of the boiler. The bottom of these stills may be either flat, concave, convex, conical, or of any other form, and the entrance of the liquor into the still, and also its discharging aperture, may be at the side, in the middle, or elsewhere, as circumstances may dictate.

Boilers or evaporators may be made upon this plan, either with or without heads, and their capacity of working may in all cases, be increased by placing layers of pipes connected thereto within the flues, between the still and chimney, which pipes may be bent or coiled in a serpentine direction, or in any other position, and the liquor to be operated upon made to pass through them, previous to its entering the still; thus the operation may be advanced to any required state of forwardness.

Stills of the above description, particularly if made square, may be divided internally, into several, each having its separate head and condenser, by which arrangement, the spirit condensed from the first, may fall into the second, to be again operated upon, and so on to a third, whereby a rectification may be carried on to any degree at one operation and by one fire.

In the still shewn at fig. 1, a set of chains are seen suspended from the bar, *e e*, supported by a centre shaft, that may be put in motion by a toothed wheel and pinion, actuated by a crank or winch. These chains hang in loops, and fall into the spaces between the partitions, to sweep the bottom of the still as the shaft revolves, and thus they prevent the material acted upon from burning, when of a thick glutinous nature, as turpentine, syrups, &c.

Ledges may be placed between each circle, on the principle more particularly explained at fig. 3, which is square, oblong or round, its bottom intersected with parallel ledges, fastened at the ends and bottom, if square or oblong; and only to the bottom if round;

except that under each alternate ledge, a space is left of any width required between it and the bottom, so that the liquid, in entering at the end or centre, passes over the one, and under the other ledge, until it arrives at the point of discharge. Thus the whole mass, whatever depth it may be in the still, is submitted to the full effect of the fire, in a layer of the thickness of the space between the ledge and the bottom.

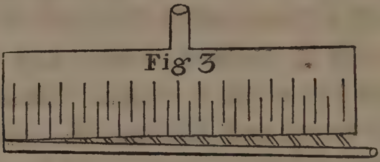


Fig 3

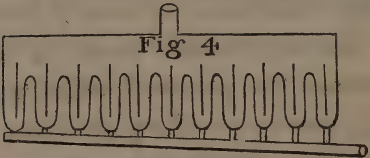
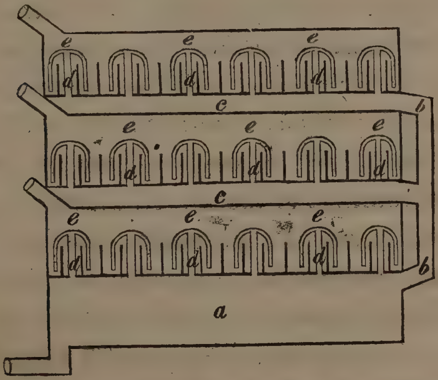


Fig 4

Fig. 4, differs essentially from all the others in this, that the bottom is doubled up and down in plaits, and presents a surface commensurate with the length, depth, and number of the plaits, between each of which (as in fig. 3), a ledge is run from side to side of the still, and fastened to both, leaving a passage the whole length underneath, between its lower edge and the bottom of the groove formed by the plait, by which the liquid, in its whole course, is reduced to a stratum of any thickness required, along a surface of immense extent, occupying comparatively but a small space, and exposed to all the ardour of the fire.

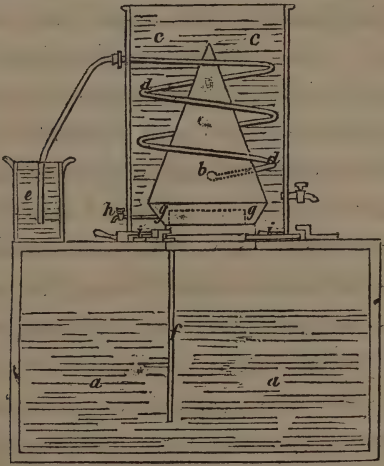
In the foregoing descriptions, the stills have been considered as in immediate contact with the fire; but it is proposed to work them by *steam*, which may be applied either externally or internally, or both, as shewn at

Fig. 5.



In this figure, *a*, represents a steam-boiler furnished with safety-valves, and supplied with water in the usual way; this boiler is surmounted by three stills, upon the foregoing principles. The bottoms are perforated at certain distances throughout their whole extent, and into each of these perforations a tube is inserted, branching into ramifications of smaller tubes, the extremities of which are bent down into the liquid flowing through the still. The steam from the boiler passes up the tube *b b*, into the hollow vessels *c c*, and thence through the tubes *d d d*, into the smaller curved pipes *e e e;* at the extremities of which it pervades the liquid in its progress. If it should be deemed more convenient or advantageous to transmit the caloric from the steam through the metal, without allowing the steam to pass into the liquid, it may be done by closing the extremities of the curved pipes *e e e*, and placing them in a horizontal position, with a small inclination, in order to allow the condensed steam to pass into the boiler. Here the spirit arising in one still might pass into another, and be again operated upon; and distilleries of every degree, and of various substances, may be carried on in one continued operation at the same time, and by one moderate fire, which upon this principle will suffice for the largest establishment known.

Another new discovery, advantageous to the art of distillation, is an apparatus by M. Deurbroucq, for preventing the loss of alcohol or spirit, during the vinous fermentation. See the annexed cut.



This apparatus consists of a vessel, or head, constructed so as to be capable of attachment to, and communication with, the back or vat in which the process of fermentation is carrying on, in the production of wine, brandy, beer, &c. The back, or vat, is to be closed on all sides, air-tight, except an opening on the top, which communicates with the head above-mentioned. This head is to be surrounded by a vessel of cold water, in order that the alcoholic vapours evolved during the process may, on rising up into the head, become condensed, and then trickle down the inside of the vessel, and descend into the vat. By the application of this apparatus, a certain portion of the alcohol, which has been hitherto suffered to escape with the non-condensable gases in the form of steam, will be condensed and returned into the liquor, while the non-condensable parts will be carried off through a pipe.

The cut represents this improved apparatus; the vat, and the cold water reservoir, being shewn in section: *a*, is the vat containing the fermenting liquor, in the top of which is an aperture communicating with the interior of the conical formed vessel *b*;

the lower part of this vessel is made cylindrical, and passes through a circular plate, on which the supporters rest; *c*, is the reservoir of cold water, surrounding the conical vessel, which may be supplied by a stream of running water; *d*, is a worm or pipe communicating with the interior of the vessel *b*, and passing off through the side of the reservoir, descends into another vessel of water, *e*; *f*, is a small pipe which proceeds from the lower part of the vessel *b*, and descends through the fermenting liquor nearly to the bottom of the vat.

The gas and alcohol rising from the liquor in the vat into the conical head *b*, and coming in contact with the cold sides of the vessel, produce a condensation of the alcohol which runs down the side of the cone into the circular channel, *g*, at its base, from whence the alcohol passes by the pipe *f*, into the vat below, while the non-condensable gases pass out through the worm pipe *d*, and finally escape by bubbling up through the water into the vessel *e*. If any portion of the alcohol should pass up the worm pipe, it will become condensed in its progress, and by the position of the worm, will be enabled to run back again, and pass into the vat. A small cock, *h*, is placed at the bottom of the cone, for trying the strength of the condensed alcohol.

This apparatus may be removed from its present situation to another fermenting vat, by drawing off the water, and disengaging the head *b*, from its place. The plate is furnished with circular wedges round the circumference, as seen at *ii*, made to act beneath hooks; the apparatus being turned round by the handles in a horizontal direction, becomes fixed in its place, having between the plate and head a ring of thick leather, to prevent the gas from escaping. The sole object and novelty proposed in this invention, is to prevent the loss of alcohol in the usual process of fermenting liquors in open vats, and to return the condensed alcohol into the liquor again.

If alcohol of 80° be put into a bladder until it is half full, the orifice closed, and the bladder then exposed to the sun, the air, or heat of a stove; after a short time the alcohol will be found rectified to 40°; and thus may all the water be evaporated without losing any of the spirit. If water be added to make up the diminished weight, the alcohol will return to 30°; and this may be accomplished by hanging the bladder in a humid place for a few days. By the application of this principle to domestic purposes, wine or spirituous liquors may be evaporated to any required strength, while their reduction in bulk will serve as a criterion of their previous state.

The method of distilling in Scotland is now much the same as that practised in England, and the process observed in the preparation of the wort or *wash*, is little different, except in the production of *strength* or *density*, that being a matter of choice with the distillers of Scotland, whilst it is a point of necessity with those of England.

The grain spirits manufactured in Scotland are made either from malted barley, or bear, called also *bigg*, a grain of the same nature, but inferior in quality to barley, or from a mixture of such malt with barley or bear, raw or unmalted. Wheat is sometimes used, but its high price in general limits its distillation.

The malt, or mixture of it, when ground, is mashed in a quantity of hot water, either by machinery or by workmen, with rakes provided for the purpose. When the fluid becomes perfectly impregnated with the saccharine or farinaceous and fermentable part of the grain, it is drawn off into an under back, or receiving vessel adjoining the kieve, and in this state is called *worts*. From the under back it is pumped into coolers, and allowed to cool down to a certain degree of heat, and then run into tuns or backs, where, with the addition of yeast or barm, it ferments, and when attenuated, is called wash. From this wash, *imperfect* spirits, or *low wines*, are distilled; and when these have undergone a second distillation, they are sold in Scotland for consumption; but in England they cannot be used for drinking in that state, but pass under the name of *raw spirits* from the distiller to the rectifier, who prepares them for the consumer.

A very simple and commodious form of a Woulfe's apparatus, is given by the late Dr. W. Hamilton, at the end of his translation of Berthollet on Dyeing. This apparatus, besides other advantages, requires no lute; has no bent tubes that are difficult to adjust, and liable to break; and the retort may be removed at any stage of the process, either to find the weight it has lost, or for any other purpose, the receiver being in the mean while closed with the stopple. Similar advantages attend Mr. Knight's still.

The late improvements in the construction of boilers and condensers, principally refer to the apparatus for condensing, and that employed for engines worked by steam at a high power. Mr. Clark's boilers, &c. for this purpose, are constructed of a multitude of bent tubes placed in an erect position, by which a greatly extended surface is exposed to the action of the fire. The extremity of the tubes open into chambers filled with water, from which the tubes are supplied and kept constantly full. The advantages of this boiler or condenser are, first, its capability of working without any danger of exploding; secondly, it will occupy very little space with respect to the power gained, and will diminish the size of the engine in nearly the same proportion; thirdly, it will expose a great surface to the action of the fire; and in consequence of the metal of the tubes being thin, they will take in the heat very rapidly; fourthly, it exposes little surface to the external air, whilst the part which is exposed, being very thick, little of the heat can pass through; fifthly, being worked with distilled water, it will seldom or ever require cleaning out, nor be liable to have a concretion of stone, salt, or other substance on the interior surface, which in ordinary boilers frequently prevents the heat passing to the water, and is also the cause of the boiler at those parts becoming red hot, and rendered unserviceable. The claims of Mr. Clark as patentee, are; 1st, raising the steam in small curved tubes; 2nd, making those parts of the condenser exposed to the action of the fire, thin in the metal; 3rd, those that are not so very thick and strong; and guarding them from the fire, to prevent injury by expansion or contraction; and lastly, combining the boiler with the condensers, by which it can be wrought with distilled water with only a very little additional supply; condensing the steam from engines by the evaporating part of the apparatus.

The advantages of the boiler and condenser, when used together, and wrought to the pressure to which the boiler is calculated, are a saving of fuel to the quantity of nine-tenths of that now used for the common low pressure engines, besides the compactness of the apparatus, which is particularly suited to steam vessels.

CHAP. III.

UPON THE STILLS USED IN SCOTLAND, FRANCE, FLANDERS AND HOLLAND.

The stills commonly used in other countries are of large dimensions and very deep, so that much time is necessary to finish one process. Once in the week, for example, is no uncommon period. The same kind of still was used in Scotland till about the year 1787, when the duty began to be levied on the distillers by a license, paid at the commencement of the season upon every still, according to its capacity. To prevent smuggling, the quantity of spirits which a still of given dimensions would produce, was calculated, and the license laid on accordingly. Thus, after the excise officers had gauged the stills, and collected the license duty, they only paid an additional visit to see that no new still of larger dimensions was substituted for the old one.

About the year 1788, Messrs. John and

William Sligo, rectifiers at Leith, made an important alteration in the shape of the still, at the suggestion of an Englishman, which greatly increased the rapidity of distillation. They diminished the height of their stills, and increased the diameter of their bottom, so that they were able to throw off the contents in a few hours, instead of once a week, as had formerly been the usual practice. This lucrative improvement they possessed exclusively for about a year; but a secret of such importance could not long be confined to a single house. It became gradually known to other distillers, and was soon imitated by all. In vain the license duty was increased year after year; but in 1799 a Committee of the House of Commons was appointed to investigate the subject. The bulky report published by that Committee, contains a vast collection of curious facts respecting the mode of distillation in Scotland; and the license was not laid upon the still, but upon the distiller. Since that period, 1799, the time of discharging the still was considerably shortened; but the saving in point of time was attended with such an enormous waste of fuel, that it was doubtful whether the distiller obtained much more profit than before. In the year 1815, the last of the license duty, a still, holding eighty gallons, could be completely distilled off, emptied, and ready for a new operation in three minutes, or three and a half; and a still of forty gallons in proportion. The license duty was then abolished in Scotland, and the whole levied as in England, on the wash, and the spirits produced. Of course the necessity for rapid distillation continued no longer.

Among the plans suggested for the improvement of distilleries, one of a curious nature was proposed by a Mr. Birch of Roscrea, calculated to obviate the difficulty of procuring fuel, and to work a still much more advantageously by the application of steam, than by the use of either turf or coals. In carrying on this experiment, the liquor in the still was boiled by the force of steam raised in a boiler prepared for that purpose, and conveyed by a pipe which communicated with the exterior of the still only; but filling up with steam the spaces or interstices made in the formation of the still, and also the space between the still itself and its case, which case was made of wood, and every part of it exposed to view.

Previous to the trial, which was conducted at Roscrea, there were four furnaces independent of the steam engine, one for the still, and one for each copper, which contained two hundred and twelve superficial feet; but by the proposed plan of working these furnaces, these were reduced to two, containing only sixty-four superficial feet subject to the influence of fire. It moreover appeared, that steam not exceeding two hundred and twenty-five degrees of temperature, was able to produce the highest charge of the excise laws, with a saving of four-fifths of the fuel, and the same of all other attendant expences. This ingenious method of distillation was ultimately rejected by the Board of Excise, on the principle that it would afford facilities to smuggling under the existing regulations; but since the act of the 4th Geo. IV. chap. 94, has relieved the distiller from the production of a limited quantity in a given time, this steam method has been thought worthy of a serious reconsideration.

These stills were made of copper. Those capable of holding forty-four gallons were about forty-four inches in diameter at the bottom, and about five inches deep; those holding eighty gallons were fifty-four inches in diameter, and about eight inches deep. The bottom was perfectly flat, and about three-eighths of an inch thick. Within it there were a number of iron chains that turned round by machinery, and rubbing against the bottom, prevented the thick matter, which the wash always contains, from adhering to the bottom of the still, and catching fire. This might have occasioned the immediate destruction of the still, and the scorched starchy matter would have communicated a disagreeable flavour to the spirits, which could not have been got rid of afterwards. There was likewise a circular plate in the inside of the still, towards its top, which broke the bubbles that rise during rapid distillation, and lessened the risk of the still boiling over, or *running foul*, as the distillers term it; consequently the distiller was enabled to put a greater charge of wash into the still, than it would have been in his power to do, had this circular plate been omitted.

The present stills, though much larger in size, imitate the others in the great diameter of their bottom. The top of the still ends in a kind of tube bent downwards, and connected with a tin tube, which makes a number of revolutions in a large vessel filled with water, and therefore called the worm. This large vessel is called the *refrigeratory*, or cooler, and care is always taken to keep its situation in a state to do this, by means of a stream of water constantly flowing into it. The wash being put into the still, and the top fixed down, heat is applied to the vessel till it is made to boil. The spirits being more volatile than the water, go over first in the state of steam, and are condensed into a liquid as they pass through the worm. The first portions that come over are very strong, but the strength diminishes as the process proceeds. The distiller continues the operation till the liquid which flows from the worm is as heavy as water, or till the quantity of spirits remaining are not considered as a compensation for continuing the process any longer. The strength of the liquor proceeding from the worm, is ascertained by a small hydrometer, with which it is tried every now and then; and whenever a certain mark on the instrument comes to coincide with the surface of the liquid, a cock at the bottom of the still is opened, and what remains in the still is let off. This is called *the spent wash.* It is a muddy brown liquid, and still retains a quantity of undecomposed saccharine matter, which has been frequently used as food for cattle.

To prevent the still from boiling over, which is apt to happen towards the commencement of the distillation, it is usual to throw a piece of soap into the vessel along with the wash. The oily matter which the soap contains being spread on the surface, forms a thin coat, which breaks the large bubbles when they rise, and thus prevents the wash from swelling beyond its usual bulk. Butter would be less liable to communicate a disagreeable flavour; and so perhaps would hog's-lard. It is impossible to lay down any rule with respect to the strength of the weak spirit obtained by this first distillation; this must depend partly upon the strength of the wort, partly on the attenuation which has taken place during the fermentation; but chiefly upon the attention of the distiller to distil off the whole of the spirituous portion of the wash.

The low wines are put into the still, and subjected to a second distillation, which in Scotland is called *doubling*. The first portion which comes over is a milky liquid, known by the name of *foreshot*. Its taste is disagreeable, and on that account it is received by itself, and returned back into the low wines, to be subjected to another distillation. The third portion is called *feints;* this is mixed with what is called the low wines, and distilled again.

The late Mr. Smithson Tennant, Member of the Royal Society of London, published a Memoir upon the means of saving fuel in distillation, in which it is observed, that the experiments of Dr. Black, repeated by Mr. Watt and other naturalists, have long since demonstrated that the quantity of heat necessary to carry the water to a temperature of fifty degrees Fahrenheit (or eight degrees Reaumur), or to the ebullition two hundred and twelve Fahrenheit, is only the sixth part of that which is afterwards necessary to convert boiling water into vapour. As this vapour is not warmer than boiling water, Dr. Black gave the name of *caloric* to the latent heat that the water had absorbed; but this was only employed in maintaining the same water in that state of aeriform fluidity which it had assumed.

From the instant that this vapour has condensed, the latent heat supplies it afresh, and even in so great a quantity, that it is often found advantageous to make use of this condensed vapour to warm other bodies. However, though by this means they may raise the water to the temperature of a boiling heat, they cannot carry it beyond this, and consequently reduce it to vapour.

As soon as the vapour has communicated its proper temperature to the water, the caloric is found in equilibrium in each of these fluids; and as there is no reason why this should accumulate in one body more than in another, the vapour passes over the water without condensation.

If, on the contrary, from any cause whatever, the vapour should condense, it can only be in yielding to the water with which it comes in contact, or a part of the caloric which holds it in a state of uniform fluidity; then in consequence of this addition of caloric, the water will convert itself into vapour, and by this means be distilled without any augmentation of fuel. But though this phenomenon does not occur in ordinary circumstances, it is easy to be effected in the manner following.

The temperature necessary to convert

any fluid into vapour, depends upon the pressure of the atmosphere upon its surface; the temperature may then be lowered, and this pressure diminished. Thus the water no longer supporting the weight of the air, will be converted into vapour of a temperature above the point of ebullition; consequently it may be distilled by a vapour of the ordinary heat.

To produce this effect, a vessel, and a recipient, which will communicate with it, must be used; this must be rendered completely impenetrable to the air, and the vapour must be passed along a worm, or spiral tube of metal.

In applying the heat to this vessel, a vacuum will be easily produced, till the vapour escapes through its orifice, and passes into the recipient; then the stop cocks may be closed, and the fire withdrawn. The distilled water is taken into the recipient, which is kept cool for this effect.

The late Mr. Smithson Tennant constructed an apparatus upon these principles, principally with the intention of explaining the theory of latent heat, or the capacity of bodies for containing caloric in different states; and it may also be of some practical use every time it may be necessary to use economy in fuel.

He was likewise convinced by many experiments, that this apparatus might be highly useful on board ships, in procuring them fresh water in cases of necessity, as he remarked that the quantity obtained is nearly double to that which is furnished by a simple boiler. In one experiment he obtained, through the second alembic, a product equal to three quarts of that produced by a former effort, and he was also convinced that a much greater quantity would be had if the second alembic was wrapped round with flannel, or any woollen stuff, which might act as a conductor to heat.

Though sea water will not enter into ebullition at a temperature as low as that of fresh, yet the difference is not so great, compared with the heat of the vapour formed under the ordinary pressure and that *in* *vacuo.* A great advantage would therefore result from applying this process to the distillation of sea water.

This memoir, it has been observed, would furnish persons engaged in distillation *in vacuo* with excellent ideas, as we are not yet acquainted with the importance of this mode.

As the thermometers of Reaumur and Fahrenheit are occasionally referred to in this work, and others upon the subject of distillation; therefore, in order to establish a correspondence between them, and to convert the degrees of the former into those of the latter, multiply the degree of Reaumur by 9, divide the product by 4, and to the quotient add 32; the sum expresses the corresponding degree on the scale of Fahrenheit. Secondly, to convert the degrees of Fahrenheit into those of Reaumur: from the degrees of Fahrenheit substract 32; multiply the remainder by 4, and divide the product by 9; the quotient will be the degree according to the scale of Reaumur: and so on for the rest.

Some recent discoveries on the water most conducive to fermentation, are also deserving the attention of the distiller. Rain or river water has been generally admitted as the most proper for this purpose; but a learned foreigner asserts, that this notion originates in a false application of chemical theory. The distillation of spirits from grain, appears to have reached its greatest perfection in Germany, and particularly in Holland and French Flanders, where 55, 60, and even 65 *litres* * of spirits at 19°, are regularly extracted from a quintal of barley; whilst the distillers of the East, and other parts, do not obtain on an average more than 40 to 44 *litres* from the same quantity of grain; and some scarcely more than from 30 to 35.

M. Dubrunfaut of Lisle, enquiring into the cause of this among the distillers, they all agreed that they had suffered too much from the use of river water, ever to try it again; and one person observed, "that the water which flowed over pebbles was the best." From the elicitation of this ray of light, M. Dubrunfaut did not hesitate a moment in pointing out this circumstance as an important cause of the great superiority of the Flanders distilleries.

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* A litre contains two wine pints.

He also inferred from experiments pointed out by Higgins, that to prevent the acid fermentation so much dreaded by distillers, there could be no doubt that *well water*, charged with carbonate of lime, held in solution with the aid of an excess of carbonic acid, might have the same effect on the process of our distilleries; as calcareous stones have less efficacy on the fermenting processes of some of our planters.

It is scarcely needful to point out the impropriety of distilling river waters, or others liable to contain animal or vegetable matter, as it is well known that such distilled water is liable to putrefaction. The water to be distilled, should be the most complete spring water, taken from some place where it has not run over any vegetable soil.

The Flemish Kiln proposed by M. Chaptal.

M. Chaptal has censured the former construction of kilns with just reason. He observes, that in all of them, the entrance is too near the mouth of the chimney; and that from this reason the heat does not remain long enough under the still, whilst the current of air in this direction carries the heat up the chimney too soon. "They leave," says he, "a void between the still and the brick-work, because the constructors of them think that by so doing, the flame will curl all round the still. But this is an error they might easily be convinced of, by taking off the top of the still after it had been used in distillation for some time. All round this, excepting on the side towards the chimney, they would perceive a species of soot, or rather a very fine grey powder. But certainly if the flame had run all round the empty space, they would have found neither powder nor soot. Both heat and flame always follow the current of air; and it is an incontestible truth, that the space they traverse in these kilns, is from three to four feet, whilst they might run twenty at least. Thus both flame and heat reach the flue or chimney, but with considerable loss, as the still does not receive above four-fifths of the heat it ought to have.

"A great advantage would attend these stills intended for the distillation of wines, if a tube was made to occupy a spiral direction like a worm round the still, for the purpose of preserving the heat and the flame a considerable time longer. Nothing is more easy to effect."

M. Chaptal would have these kilns to be of the common height, the bottom completely exposed; and in the part opposite the door, the spiral tube should commence, eight inches by six. It should wind round the still up to the flue or chimney; and it is evident, that by this means the flame would continually play all round, the part only excepted that comes in contact with the brick-work. Thus, supposing that the tube made but three turns round the still in its progress from the bottom to the top, you would at least have from thirty to thirty-six feet of pipe, from which the flame would be immediately applied to the still, whereas in the common way there is not more than three or four feet of immediate contact.

This manner of constructing stoves or kilns, has long been adopted in Flanders, and was recommended by M. Chaptal in 1801. There can be no doubt that they are very well contrived, and that every one who has adopted them have experienced no small saving in the expence of firing, as well as advantage in the quality of the products or goods. The fire being better directed, and the stove completely surrounded, the ebullition is sooner produced, and being once heated to a proper degree, little firing will be sufficient to continue it, as none of the heat is lost.

A small Alembic for the Trial of Wines.

It was for a long time a desideratum at Paris, to discover some easy mode of ascertaining the quantity of alcohol or pure spirit in wines destined for distillation.

About the end of 1810, a patent was granted by the French government, for an aereometer that was to answer the intended purpose, by being plunged into the wines that were to be tried, with an addition of carbonate of lime. This, however, not bearing the test of experience, came to nothing; and it was found necessary to have recourse to distillation. M. Descroizilles therefore resolved to attempt the construction of a small alembic heated by spirits of wine. The point most embarrassing, was the refrigeration or cooling, necessary to condense the vapours. The common mode required a vessel larger than the whole of the new intended apparatus. In this, only a little water was wanting; however, this difficulty being got over, it was found practicable with a small lamp, to obtain a sufficient quantity of brandy in the course of half an hour. A glass vessel which served as a recipient, by a very simple operation was filled with a mixture, in arithmetical proportion with the different wines contained in a number of tuns of various capacities.

This new instrument, which would admit of the distillation of even a glass of wine, and afford the product in half an hour, was found to be such, that it might be repeated at pleasure many times in a day. It was observed, that people who had orange trees, and who could only collect a few of the flowers, had now an opportunity of amusing themselves in drawing distilled waters. They had nothing more to do, than to put the water into the little alembic, and then to lay the flowers upon the two gratings, across which the water was to pass in a vapour, in order to be condensed in the receiver. People might also make similar experiments in distilling rose water, mint, peppermint, &c.

It was at the same time observed, that a great number of exotic vegetables cultivated in green-houses, contained volatile oils and aromatic qualities, scarcely known till lately, because their leaves, flowers, seeds, roots, and barks, were too small to be distilled in the ordinary manner; but with this little alembic for the trial of wines, repeated distillations might be made at the different epochs of the growth of these articles, and their products duly estimated. Besides, as physicians often recommend distilled waters, sometimes not to be had, some ounces were now obtained in an hour. Further, in any course of chemistry, this little alembic could be mounted upon a table in an instant, round which the professors might be sitting, and easily afford its products in the course of a lecture, besides serving as a kind of demonstrator with the greatest dispatch.

This apparatus in miniature being constructed of the best tin, is of an agreeable form, and unites in itself all the facilities for the operations for which it is intended. It requires no wrapping in paper, no luting, &c.; all the joints, however, are very exactly closed; and few instruments are better adapted. Young persons who may have very little instruction, may now indulge with the wish to study the arts of distillation, perfuming, or the making of sweet waters, and of chemistry in general.

Nearly the whole of the parts may be

enveloped in linen cloth, in which they may be rolled up in a minute with as much ease as safety in securing them from coming in contact with each other. They are frequently enclosed in an oblong sack, which in its turn is put into a cylindrical tin box, sixteen inches long, and about three and a half in diameter. Even the cover of this box is an essential part of the whole apparatus. The weight of the whole is not more than six pounds and a half, including a tin vessel full of alcohol.

Machine to prevent the Inconveniences resulting from the inequality of Heat in Distilling.

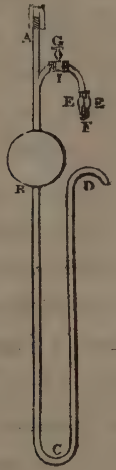
Every distillation consisting principally of two operations, viz. the conversion of the matter into vapours by heat, and the condensation of the same vapours by its opposite; therefore, that this twofold operation should be effected with promptitude, and at the least expence for combustibles, it is necessary that a perfect equilibrium should be established between the heat in evaporation and the condensing cold in resisting the latter, by means of a given quantity of water of fixed temperature passing through the cooler in a given time.

It is necessary that the fire should be regulated in such a manner, that the quantity of vapour produced, should be neither greater nor less than that which, at the same time, may be condensed by the application of cold. The failure of attention to this circumstance (especially in the distillation of spirituous liquors), may produce the following inconveniences: first, if the fire is too violent, a great quantity of the condensed vapours will pass from the worm into the external air, and occasion the loss of the matter distilled, and also of the fuel.

Secondly, if the fire or heat is diminished too soon, the condensation will produce a vacuum in the worm and in the alembic, which not being proportionably filled by the fresh vapour, will admit the entrance of the external air, and impede both operations; and lastly, being compelled to issue out afresh, will carry with it a part of the vapours, and occasion loss of time, and also of the matter distilled.

To remedy these defects, and at the same time to provide simple and effectual means for indicating the exact state of the heat every instant, M. le Chevalier Edelcrantz invented an instrument which may be adapted to any distillery or apparatus, and is in reality nothing more than an application of known and practical principles.

This ingenious machine possesses another singular advantage, which escaped the inventor, namely, that in intercepting the communication of the atmospheric air, the products of the distillation are more abundant and perfect; for in proportion as the vapours condense, a vacuum is formed in that part of the apparatus into which the vapours are drawn, in the same manner as by the pump; they are also less compressed in every part of the apparatus which they may fill; the condensation is more rapid; and the products upon the whole, infinitely superior. To render this instrument still more useful, its lower part should be completely immerged in a vessel filled with cold water, up to the ball; the liquor, though ever so little impregnated in traversing this cold fluid, will complete the deposition of its caloric. This precaution will also prevent the losses that frequently result from the negligence of workmen.



Explanation of the Cut.

ABCD, a tube of copper or glass in several pieces, bent over with a ball B, eight inches in diameter. The upper end of the tube A, may be attached to the worm by the means of a vice. The length of B C, C D, is four feet, and the capacity of the ball B, is something more than that of the tube B C D. The distillation having commenced, the vapours condensed will pass through A, and the ball B, into the tube B C D. But it will only be when the two arms are filled, that the liquor will go out through D, to enter the vessel intended to receive it. These two arms will then remain filled during the whole process of the distillation; and in this consists the remedy of the inconveniences the instrument is intended to remove. It is easy to see, that if the fire becomes too brisk, the uncondensed vapour will not be able to disengage itself, by opening a passage to the external air, before having driven out all the liquor contained in the tube B C, and overcome the pressure of a column, the height of which is equal to C D.

In the second place, the external air cannot enter to occupy the void occasioned by the slowness of the fire, but only by expelling that from D C, and surmounting a pressure of the same height. Still this column being four feet in height, allows a sufficient latitude and time for the workmen to regulate the fires.

If the tube B C D, was of glass, it would only be necessary to observe the level of the liquor in the two arms. Its being lowered in B C, would indicate the necessity of diminishing the fire; and in C D, it would be necessary to increase it. But as the operation in tubes of this length is rather precarious, it would be best to attach to E a little glass regulator, E F E, of which the two arms E F, each being three inches long, containing mercury, this, in rising alternately in one or the other, would be an exact indication of the degree of the heat, and also of the vapours. This regulator might be enclosed so as to prevent it from accidents. Betwixt this and the worm is the stop-cock G, which in the beginning of the operation communicates with the external air in the same manner as the cock of an air pump; but after the fire has been forcibly driven, the vapours may be seen issuing out of I;

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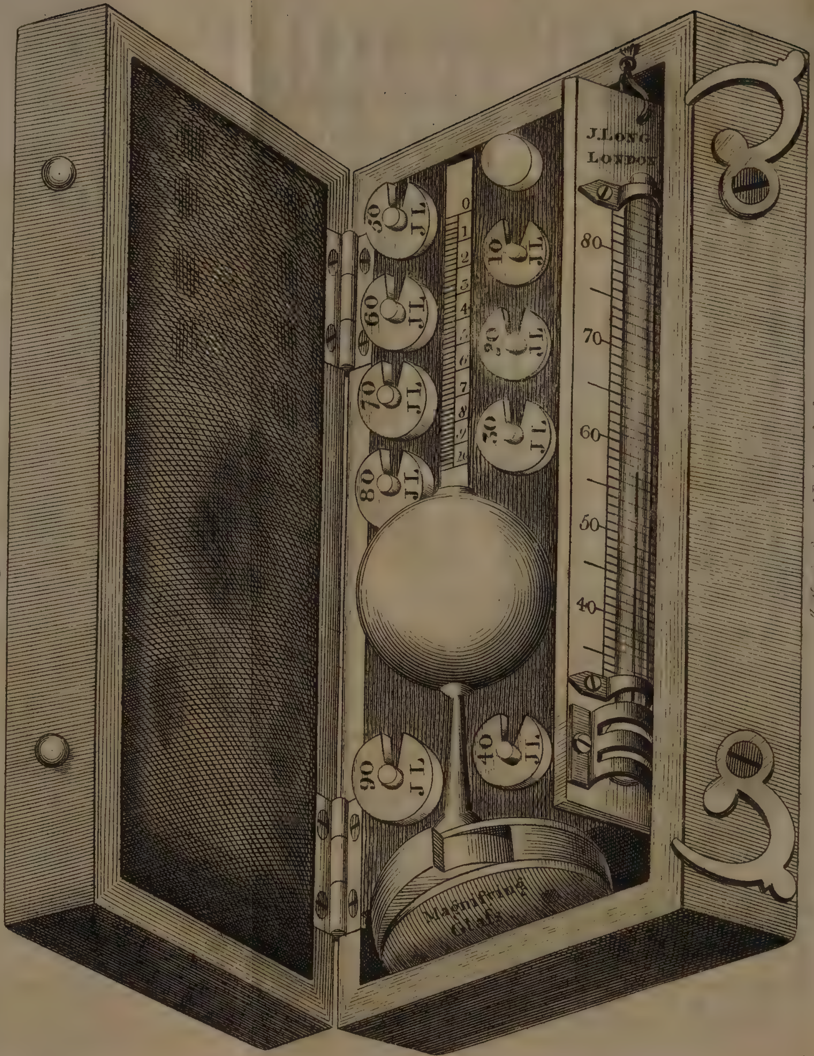

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then turning this cock, the communication between the worm and the external air is closed, and the other between the same worm and the regulator must be opened, and the functions of both will commence. The ball B prevents the liquor driven by the external air from rising in E F E, and in the alembic. It is almost superfluous to add, that the head, whatever its form may be, should be well luted, in order to prevent the entrance of the external air.

Hydrometers and Saccharometers now in use.

The strength of spirits, Dr. Ure observes, is determined according to the existing laws by Sykes's hydrometer; but as many dealers use Dicas's, he thus describes the latter. It consists of a light copper ball, terminating below with a ballast bottom, and above with a thin stem, divided into ten parts. The upper extremity of the stem is pointed, to receive the little brass poises or discs, having each a hole in its centre, numbered 0, 10, 20, 30, &c. up to 350, which is the lightest of the series. The intermediate units are given by the subdivisions on the stem. A graduated ivory scale, with a sliding rule and thermometer, accompanies the hydrometer, to make the correction for temperature. The first thing in using this instrument, is to plunge the thermometer into a glass cylinder, containing the spirits to be tried. The sliding rule has then the degree of temperature indicated, moved opposite to zero. The hydrometer is now placed in the liquid, and such a poise is put on, as to submerge a portion of the stem. The weight added to the number on the stem, gives a sum, opposite to which on the scale we find the quantity, by which the particular spirit may exceed or fall short of proof. Thus, if it mark twenty under proof, it signifies that every hundred gallons of that spirit would require to have twenty gallons of water abstracted from it, to bring it up to proof. If it mark ten over proof, we learn that every hundred gallons contain too little water by ten gallons. When the thermometric degree of 60°, is put opposite to zero, the weights and value of the spirits have the following relations on the scale.

1025 denotes 20 under proof.
1220 — 10.
1435 — proof.
167 — 10 over proof.
193 — 20.
221 — 30 over proof.
251 — 40.
284.5 — 50.
822.5 — 60.
350.5 — alcohol.

There is besides an upper line on the scale, which exhibits the relation of spirit to water, reckoned unity. Thus, above ten per cent. over proof in the second line, we find in the upper line eight.

Sykes's hydrometer, generally used in the collection of the spirit revenue in Great Britain, consists first of a flat stem 3.4 inches long, which is divided on both sides into eleven equal parts, each of which is subdivided into two, the scale being numbered from 0 to 11. This stem is soldered into a brass ball 1.6 inch in diameter, into the under part of which is fixed a small conical stem, 1.13 inches long, at whose end is a pear-shaped loaded bulb, half an inch in diameter. The whole instrument, made of brass, is 6.7 inches long. The instrument is accompanied by eight circular weights numbered 10, 20, 30, 40, 50, 60, 70, 80, and another weight of the form of a parrallelopiped. Each of the circular weights is cut into its centre, so that it can be placed on the inferior conical stem, and slid down to the bulb; but in consequence of the enlargement of the cone, they cannot slip off at the bottom, but must be drawn up to the thin part for this purpose. The square weight of the form of a parallelopiped, has a square notch in one of its sides, by which it can be placed on the summit of the stem. In using this instrument, it is immersed in the spirit, and pressed down by the hand to 0, till the whole divided part of the stem be wet. The force of the hand required to sink it, will be a guide in selecting the proper weight. Having taken one of the circular weights which is necessary for this purpose, it is slipped on the conical stem. The instrument is again immersed, and pressed down as before to 0, and it is then allowed to rise and settle at any point of the scale. The eye is then brought to the level of the surface of the spirit, and the part of the stem cut by the surface, as *seen from below*, is marked. The number then indicated by the stem is added to the number of the weight employed, and with this sum at the side, and the temperature of the spirits at the top, the strength *per cent* is found in a table of six quarto pages. The strength is expressed in numbers denoting the excess or deficiency of proof spirit in any sample, and the number itself (having its decimal point removed two places to the left), becomes a factor, whereby the gauged contents of a cask or vessel of such spirit being multiplied, and the product added, if over proof, or deducted from it if under, the result will be the actual quantity of proof spirit contained in such cask or vessel.

The use of the saccharometer was known for many years by distillers, but its adoption by the officers of excise is rather of a recent date. It is a simple machine, and is nothing more or less than what its name imports, *a measure of sweetness;* it was constructed to ascertain the sweetness of worts, to compare their weight with that of equal quantities of the water employed. In fact, it may be said to be a *hydrometer* calculated to shew the specific gravity of wash instead of spirits. For as spirituous liquors are strong in proportion to their levity, or weak in proportion to their gravity, hence, as the hydrometer will sink deeper in strong than in weak spirits, so the saccharometer will sink deeper in weak than in strong worts.

Of the number of instruments of this kind, perhaps none have met with more general sale than Mr. Dicas's of Liverpool. It is calculated to shew the gravity or saccharine matter in an English ale barrel of 60 lbs. gravity, equal to forty-four gallons wine measure. When a wort therefore is stated upon it to be 60 lbs. gravity, the meaning is, that forty-four gallons of such liquid, weighs its weight of water, and 60 lbs. more.

The instrument now adopted by the act, is the invention of Doctor Thompson of Glasgow, whose attention was called to the gravity of worts whilst he was employed under government in some experiments in distillery. This instrument bears the name of Mr. Allan, who is the maker; it differs from that of Dicas in a very immaterial degree, and was used by the excise officers in Scotland previously to the passing of the present law.

Bate's saccharometer. The saccharometer of Mr. Allan, the one mentioned in the act of 4 Geo. IV. cap. 94, has been laid aside, and a new one substituted in its place, by an order of the Lords of the Treasury, dated 17th October, 1823. It is called Bate's saccharometer, from the name of the maker, Robert Brettel Bate, late of London, and appeared to be an instrument well calculated to answer all the purposes intended.

It has been observed, that spirits of wine have the greatest strength of any, and though these may be raised by using salt of tartar, yet when it is exposed to the air it almost immediately falls down to its first and general strength of spirits of wine. Water then is naturally to be supposed to be of the lowest temperature and quality; and the term called hydrometer strength, is exactly the half between the two: so that if one gallon of spirits of wine and one gallon of water are mixed together, the result will be, two gallons of spirits at hydrometer proof. The trade, when speaking about the strength of their goods, use the expression, one in five, one in three, one in eight, &c.; or else, one to five, one to three, &c. Thus all spirits *under* the said hydrometer strength, are called *in;* but if *above,* they are called *to;* for instance, if certain goods are said to be one in eight; it means, that to every eight gallons of spirits at hydrometer strength, one gallon of water is added; or what the distillers and rectifiers call *liquor.* One in five, shews that to every five gallons of hydrometer, one of water is added, and to one in four, one of water; and so of every different degree under the hydrometer proof. The characters of these to the trade are H P.

One to ten, shews that one gallon of water put to ten gallons of spirits, will make it of hydrometer strength. One to three, means that to every three gallons of spirits, one of water may be added. The mark to express what is above hydrometer strength, is O P; and under the same, U P. To make a proper use of the hydrometer, the distiller or chemist are directed to fill the glass tube with the spirits intended for trial; then immerse the thermometer in them for the space of two minutes; this will cause the mercury in the tube to stand at the degree equal to the temperature of the spirits. Whatever the weight of the air may be, above where the mercury stands, must be applied. If the quicksilver stands *above* very cold, the weight colder, must be added, and so of the rest.

Each degree of the thermometer is about two degrees on the spindle of the hydrometer, and each degree of the hydrometer, when at or near proof, is about a quart in a hundred gallons stronger or weaker, as the hydrometer shews under or over the silver speck, or sight, on the index, or top spindle; and at the intermediate or strong over proof, is about a pint in ditto; and at the low under proof, is about three pints in ditto: and it should be further observed, that it would be better to immerge or wholly to wet the hydrometer, in the liquor to be tried, that it may adhere with more facility to the instrument while it is in a state of vibration, or floating.

CHAP. IV.

DESCRIPTION OF A DISTILLERY CONSTRUCTED UPON THE BEST PRINCIPLES.

Translated from the French of M. M. Chaptal and Le Normand.

When any one would undertake the establishment of a distillery upon a grand scale, it is incumbent on them to make every preparation necessary, to facilitate their labours, insure the preservation of their materials, preserve their products, and employ as few hands as possible. The space destined for a distillery, should of course be large. It ought to contain a plentiful spring, excellent cellaring, vaults, store-houses, &c. A situation near a stream of water is of all others the most preferable, if in the country, but by whatever means water may be obtained, it will be necessary to be secured against the possibility of failure at any time. The cellar should be considered as the magazine in which all the wine, previous to its distillation, should be deposited; and ought to occupy the same space under ground as the distillery above it. M. Chaptal observes, the best and most perfect cellar is that where the thermometer is always between ten and fourteen degrees of heat by the scale of Reaumur. The farther the temperature of this part deviates from this standard, the worse it is. If a cellar has not a sufficient depth, it is necessary to dig it deeper; if too much exposed to the air, surround it with walls, increase the doors, and diminish the air-holes; stop up those that are not well placed, and open fresh ones that will introduce a new current of air. A cellar ought to be at least about sixteen feet in depth, the roof about twelve feet high, and the whole bottom covered with about four feet of earth. The entrance should always be within two doors, one of which should be at the top of the stairs, and the other at the bottom; and this is equal to a gallery. If the entrance should look towards the south, it is absolutely necessary to change it, and carry it to the north. Cellars whose entrances are towards the south or the west, are always detestable. Every one perceives the reason of this. In proportion as the heat of the atmosphere after winter, increases eight or ten degrees, a certain number of the air-holes must be closed, because the air of a cellar always endeavours to put itself in equilibrium with that of the atmosphere. On the contrary, during summer, it is proper to admit the external air to a certain point, to diminish the heat of the cellar. Here, however, some restriction is necessary: if the external air is of ten degrees, then the air-holes may be closed; prudent conduct with respect to the air-holes will preserve the wine, and prevent its being injured whilst in the casks.

A good cellar for wine, spirits, or beer, ought to be at a proper distance from the passage of carts and carriages, shops, or forges of workmen who are continually in the use of the hammer and anvil. Their blows affect the vessels as well as the fluids they contain; they also facilitate the disengagement of the carbonic acid, the first connexion of bodies; the lees combine with the wine; insensible fermentation is augmented, and the liquor more promptly decomposed. A cellar cannot be too dry; humidity undermines the tuns; moulds and rots the hoops till they burst, and the wine is lost. Besides this, humidity penetrates the casks insensibly, and at length communicates a mouldy taste to the liquor.

Experience has proved in France, that wine preserved in vast tuns, built into the stone walls of good cellars, increases in spirit every year. These tuns are not subject to running like the common casks, and also contribute very much in point of economy, and in the end are less expensive than wood. For one apparatus, the space appropriated to a distillery, properly speaking, should not be less than from forty to fifty feet by fifteen or twenty; but this is only to be understood of distilleries of wine or spirits. A large yard or court is also necessary to a distiller.

CHAP. V.

GENERAL DIRECTIONS TO THE DISTILLER.

Respecting the present mode of distillation in England, the law is very explicit. There is no working against time, as has been the practice elsewhere, as before observed. The great object is to make strong worts, which have to ferment, so as to attain the greatest possible attenuation. In order to prevent fraud, it is directed that for every hundred gallons of fermented worts, nineteen gallons of spirits should be produced, that quantity being deemed the maximum which any worts are capable of yielding. Hence it became a matter of importance to English distillers, to make their worts of the greatest density, always keeping in view a perfect fermentation.

At present the average gravity of worts brewed from a mixture of malt and barley, is in all from 100 to 120 pounds of saccharine matter per barrel. But part of this gravity is made up from a mixture called *lob,* which is a powerful and strong saccharine made from barley and malt flour, and added to the brewing of the common worts. This mixture, although so high in gravity, is yet generally well fermented, being cut down so low as from six to two pounds on Dicas's instrument. This attenuation is accomplished, generally in the space of from ten to fourteen or twenty days at most. When perfectly fine, it is put into the wash-still, and distilled into low wines. These are afterwards put into the low wine still, and made into *spirits* and *feints.*

The mere working of these stills, is a simple mechanical process, to perform which, from their great size, there is plenty of time. The average charge of a *wash-still,* is from 10 to 20,000 gallons of wash at once, and the charge of the *low wine* still, is the produce of the wash from the *wash-still.*

From this Mr. Morewood remarks, "it will be seen that the particular still requisite in conducting a distillery in England to advantage, relates to the brewing of strong worts, and to the proper fermenting of them, a sort of knowledge which has absolutely become a science in the hands of those who possess it.

Of the laws under which the spirits are made, the following may be taken as an abstract. In the first place, there are preliminary formalities respecting notices for brewing, &c. When the worts are placed in a wash back, they are carefully gauged, and the quantity ascertained with the greatest nicety. Worts, either as such, or as wash, cannot be removed from a back under a severe penalty, except when a notice is given to the officer to charge the wash-still, in which notice the number of the back or backs, must be mentioned. This notice must be given at least six hours previous to the charging of the still. At the proper time the officer comes to the distillery with a bunch of keys to open the following locks, viz. the locks of the backs to be emptied, then the lock of the wash-pump, a conveyance from which goes to the wash-still; there is a cock, the lock of which is also taken off, and which eventually admits the wash into the still. This operation generally occupies from one to four hours, and always in presence of the officer who has previously taken stock.

After the wash-still is charged, which must be with less than three-fourths of its contents, the locks are again replaced and sealed up, and then the officer takes stock a second time, to ascertain the decrease of wash in the backs, which is compared with the increase in the still, and is commonly found to correspond. Such decrease stands as a charge against the distiller. The officer then locks the discharge-cock, and unlocks the furnace door of the still, which may then be said to be at work. During the working of the charge, one or two officers call to see the process, and when the still is completely off, they either re-charge under a previous notice, or if no notice is served, lock up the furnace door, and open the discharge-cock of the still. The same locking and unlocking takes place in the case of the *low wine* still. The produce of this is divided into two parts, *spirits* and *feints*, which run into separate vessels properly secured. The officer also takes an account of the quantity and strength of the *spirits* and *feints*, calculating them into spirits at the strength of seven per cent over proof, by Sykes's hydrometer; after which the spirits are sent into the general stock of the house, and the feints are run into the next, or next succeeding charge of the wash-still; and both vessels *being emptied*, are again locked up to receive a fresh produce of the low wine still.

The duty is charged upon wash only, and at the rate of 2*s*. per gallon, which, at 19 per cent produce, makes 10*s*. 6*d*. on the gallon of spirits. A return of the wash distilled in the course of one week, is made to the collector on the succeeding Monday, and the trader must pay the same at a period not later than eight days. And as no bonding of spirits for the duty is allowed in England, this regulation has tended much to keep the trade in a very few hands.

It must be observed, that English spirits, although made from very fine materials, yet, on account of the richness and grossness of the wash, rendered necessary by the 19 per cent produce, are unsaleable to the public at large, the quality of the spirit being too coarse and harsh. Accordingly, a new set of traders, denominated *rectifiers*, are called into action, between the distillers and the consumers. The rectifiers re-distil the spirit, with the addition of certain drugs and compounds, such as juniper berries, spirits of turpentine, &c. &c. with which they make a sort of compound, called British *gin*, or else with spirit of nitre, prunes, &c. make an imitation of *brandy*, or manufacture spirit of wine or alcohol, for the use of druggists. All raw spirits, whether manufactured in England, Scotland, or Ireland, must pass through the hands of these traders.

In rectifying and distilling compound goods, a small still is known to make a cleaner and better commodity than one that is larger; and one that is half a hogshead gauge, is thought the fittest size for a moderate trade, and it may be managed without fatigue, and will produce a good profit. But it is necessary to observe, that no distiller or rectifier shall have any still or stills, which separately or together shall contain less than one hundred gallons, on pain of forfeiting one hundred pounds; and such stills shall be placed in one room, under the like penalty. Spirits to be distilled should be proof goods, and be tried by having a small quantity put into a glass phial, and then shaken in the hand. If the blebs, or proof of it, remain sometime upon the top or surface of the goods, it is then what is called proof goods, (or the strength may be tried by the hydrometer, which is the best way), and when it is distilled, it will yield about two-thirds of every thirty gallons, and sometimes full twenty gallons, according as the spirits are higher or lower. These may be made proof, by adding the necessary proportion either of spring or river water. For example, all double goods coming from the still, clear proof and without feints, must be made up with liquor to that quantity the still was charged with at first; for instance, with thirty gallons of proof spirits, it will yield about twenty gallons of high proof goods, but the deficiency of ten gallons must be made up with liquor, till the whole amount to thirty gallons, the first charge; and in single goods may be added one and an half part more of liquor (viz. fifteen gallons) to what is ordered in double goods, whereby forty-five gallons of single goods may be produced; but if the spirits are below proof, upon shaking the phial, or glass, the goods will fall flat, or the blebs or proof thereof will not continue on the surface of it; and according to the degree of its being reduced more or less below proof, the goods will flatten accordingly; and when such goods are distilled, they will fall short in quantity; but by making them proof, and no otherwise, can we know what body they were of, and how far they were reduced, except by the hydrometer.

When the still is charged with goods for distilling, and luted, then make the fire under it; which if possible must be of coals, because their heat is most durable, and wood fires are very subject to both extremes, of too much or too little heat, which are prejudicial and hazardous.

Let the fire be pretty moderate at first, and then increased by degrees, and now and then stirred up with the poker, and by laying the hand upon the body of the still, as the fire gains strength in the stove or furnace under the still, you will by moderate degrees carry it up to the still-head. When this becomes warm or hot, a damp is to be prepared to check or lessen the violence of the fire.

Special care should be taken that no manner of grease, tallow, soap, or any other such-like unctuous matter, get or fall into the pieces, tubs, rundlets, or cans, because they quite take off all manner of proof of the goods, and although the strength be very high, yet they will apparently fall as flat as water, and then their strength can only be ascertained by the hydrometer.

Lighted candles, torches, papers, or other combustible matter, should never be brought near the still, or any vessel where the goods are contained, which are subject to take fire upon very slight occasions. But should an accident take place, get immediately a woollen blanket or rug, drenched in water, and cast upon the flame, which will extinguish it by excluding the air.

Some persons, after the still is charged, make a luting, or paste made half of Spanish whiting, and the other of rye-meal, bean-meal, or wheat-flour, well mixed together, and made with water, of the consistence of an ordinary paste for baking; and having put on the still-head, work and make it pliable, and spread it upon the junctures of the body and head of the still, to keep in the goods from boiling over; reserve a piece of paste, lest the luting should crack or break out, which is very dangerous.

It is a custom among some gentlemen of the trade, to put one-third or one-fourth part of proof molasses brandy, proportionably to what rum they dispose of, which cannot be distinguished but by an extraordinary palate, and does not at all lessen the body or proof of the goods, but makes them about two shillings a gallon cheaper.

To recover any goods to a better body or strength, when too low or weak, whether brandies, rums, or fine cordial waters, a proper quantity must be put by little and little at a time, of spirit of wine to the goods, mixing or stirring them very well together. They may be perfectly restored to the desired proof with little or no loss, because the spirit of wine stands at about the same price with the cordials, and costs less than some of the brandies.

To recover or amend any common waters, or genevas, will take such a quantity of proof or double goods of the same kind or denomination to the other, as the price will bear, or will answer the intentions, by such composition or mixture. If by putting proof and weak goods together, the colour or face of the goods be spoiled, which before their being mixed together were fine, as it frequently happens, they must be cleared or fined as when newly distilled: some persons throw in about a pound of alabaster powder into their mixed goods, to stop up the porous parts of the flannel sleeve, which fines them immediately.

If by chance or accident any goods happen to be spoiled in their complexion, especially genevas, which may be turned as black as ink, even by an iron nail dropping into the cask, they must be distilled over again, by putting in half the quantity of the ingredients as usual; and they will come perfectly fine as rock water from the still, and must be dulcified according to their quantity, just as they were at their first being made. But the goods, notwithstanding the misfortune they met with, will be much better than they were at their being first made; for by every distillation they are weakened near one in twenty, though improved in goodness, as before observed.

Distillers, when in drawing off and making up their distilled goods, should be often trying them in a glass or phial; and when the bell, or proof, immediately falls down, and does not continue a pretty space upon the surface, then they should take away the can of goods, and substitute another vessel to receive the feints, which, if suffered to run among the rest, would cause a disagreeable relish, and be longer in fining down; whereas the feints being kept separate, the goods will be clean and well tasted, when made up with liquor to their due quantity.

When the still is first charged, some persons add about six ounces of bay salt to every ten gallons of spirits, and so proportionably, whereby the goods will cleanse themselves, and separate from their phlegmatic parts.

Some are also in the habit of using a handful of grains to make the goods feel hot upon the palate, as if they bore a better body; yet this conduces nothing towards the advancement of the proof.

When all the goods are come off, if designed for double goods, they must be made up to their first quantity with liquor; for instance, if a still is charged with three gallons of proof spirits, they will yield in distillation about two gallons without feints;

which deficiency of one gallon must be made up with liquor, (and sugar used in dulcifying), to their determined quantity.

To single or common goods must be added, over and above the prescribed quantity in compounding double goods, one and an half part more of liquor, (viz. one gallon and an half), to dilute it for single or common goods.

When goods are to be dulcified, you must never put your dissolved sugar amongst your new distillation, till the dulcifying matter becomes perfectly cold, for if mixed hot with the goods, it would cause some of the spirits to exhale, and render the whole more foul and phlegmatic than otherwise.

To fine any goods speedily for present use or sale, (especially white or pale goods), add about two drachms of crude alum, finely powdered, to three gallons of goods; rummage them well, and the residue will immediately become clear and transparent.

It must also be observed, that what is called Hippocrates' bag, or flannel sleeve, is very necessary for a distiller or brandy merchant, as by the use of this, all bottoms of casks, though ever so thick and feculent, by putting into this bag to filter, become presently clear, the porous parts of the said bag being soon filled with grosser matter; and the thin or liquid element runs clear from the bag, and is as good as any of the rest: also any foul goods or liquor may presently be made clear and fine, by putting some powdered alabaster into the goods or liquor, or sprinkling the same on the bag to stop up its pores, by which they presently become, or run clear, leaving nothing but the sediment or gross matter in the bag; nor do the goods or liquor contract the least ill-flavour from the said alabaster powder.

The said bag is made of a yard or ell of flannel, not over fine or close wrought, laid sloping, so as to have the bottom of it very narrow, and the top as broad as the cloth will allow, well sewed up the side, and the upper part of the bag folded about a broad wooden hoop, and well fastened to it; then boring the hoop in three or four places, it may be suspended by a cord.

But the bottoms of fine goods, which are much more valuable, must be filtered or put through blotting paper, folded in four parts, one part or leaf to be opened funnel wise, and made capable to receive what it will hold of the bottoms; this being put into the upper part of a large tin funnel, will filter off all the goods from the sediment.

CHAP. VI.

ON MALTING, AS CONNECTED WITH THE DISTILLERY.

As the process of malting developes the saccharine principle of grain, it is the common practice to use about three parts of raw grain with one of malt. For this two reasons may be assigned: by using raw grain, the expence of malting is saved, as well as the duty on malt; and the process of malting requires some nicety of attention, since, if it be carried too far, part of the saccharine matter is lost; and if it be stopped too soon, this matter will not be wholly developed. Besides, if the malt be dried too quickly, or by an unequal heat, the spirit will be less in quantity, and more unpleasant in flavour. Another object of economy is to know, what grain will afford the most spirit in proportion to its price, as well as the best in quality. Barley appears to produce less spirit than wheat; and if three parts of raw wheat be mixed with one of malted barley, the produce is said to be particularly fine. This is the practice of the distillers in Holland; but in England they have been prohibited from using more than one part of wheat, to two of other grain. Rye, however, affords more spirit than wheat.

The practice of distillers in Scotland, is to use one part of malted spirit, with from four to nine parts of unmalted grain.

This mixture yields an equal quantity of spirit, and at a much cheaper rate than when the former proportions are taken. Whatever grain may be employed, it must be coarsely ground and then mixed carefully with a little cold water, to prevent its running into lumps. Water about 90° Fahrenheit may then be used till it is sufficiently diluted; and lastly, a sufficient quantity of yeast must be added. The whole is then to be allowed to ferment in a covered vessel, to which, however, the air can have access. Attention must be paid to the temperature, for if it exceed 77° Fahrenheit, the fermentation will be too rapid; and if it be below 60°, the fermentation will cease. The mean between these will generally be found the most favourable. In this country it is the most common practice to mash the grain, as for brewing malt liquors, and boil the wort. But whichever way be used, or if the *wash* (so the liquor intended for distillation is called), be made from molasses and water, due attention must be paid to the fermentation, that it be continued till the wash grows fine, which is generally on the third day; but not so long as to permit the acetous fermentation to commence. In this state the wash is to be committed to the still, of which, including the head, it should occupy at least three-fourths; and distilled with a gentle heat as long as any spirit comes over, which will be till about half the wash is consumed. The more slowly the distillation is conducted, the less will the product be contaminated with essential oil, and the less danger there will be of *empyreume*. A great saving of time and fuel, however, may be obtained by making the still very broad and shallow, and contriving a free exit for the steam. This was carried to such a pitch in Scotland, that a still measuring forty-three gallons, and containing sixteen gallons of wash, had been charged and worked no less than four hundred and eighty times in the space of twenty-four hours; a fact which would appear incredible, were it not established by unquestionable evidence: however, as before observed, this wonderful rapidity of distillation has ceased since the excise duties have been levied on the quantities of spirit produced, and not, as formerly, by the size of the still. Hence too, the spirit is probably improved in its flavour.

M. Lavoisier's application of fixed air, and his analysis of yeast, authorized Mr. Henry's conjecture of fixed air. There are many tons weight of this elastic air blended with some tons of alcohol, dissipated in great distilleries, breweries, &c. and annually in every vintage in wine countries, that may no doubt be one day or other converted to useful purposes, highly advantageous.

Professor Brande observes, that the distillers, in preparing wash, instead of brewing this from pure malt, chiefly employ raw grain, mixed with only a small quantity of malted grain. The water employed in the mash tun is of a lower temperature than is requisite in brewing beer, and the mashing must be longer continued, by which it would appear that a part of the starch of the barley is rendered into a kind of saccharine matter. The wort is afterwards fermented with yeast.

The first product of the still, technically termed *low-wine*, is again to be subjected to distillation; the latter portion of what comes over called *feints*, is to be set apart, to be put into the wash still at some future operation. Thus a large portion of the watery spirit is left behind. This second product, termed *raw spirit*, being distilled again, is called *rectified spirit*. It is calculated that a hundred gallons of malt, or corn wash, will not produce above twenty of spirit, containing sixty parts of alcohol, to fifty of water: the same of cyder wash, fifteen gallons; and of molasses wash, twenty-two gallons. The most spirituous wines of France, those of Languedoc, Guienne, and Roussillon, according to Chaptal, yield from twenty to twenty-five gallons of excellent brandy from 108; but those of Burgundy, and Champagne, much less. Brisk wines containing much carbonic acid, from the fermentation having been stopped at an early period, yield the least spirit.

The spirit thus obtained should be colourless, and free from any disagreeable flavour; and in this state it is fittest for pharmaceutical purposes, or the extraction of tinctures. But for ordinary sale, something more is required. French brandy, though not in the highest esteem here, and perfectly colourless when first made, and often preserved so for use in France, by being kept in glass or stone bottles, is put into new oak casks for exportation, whence it soon acquires an amber colour, a peculiar flavour, and something like an unctuosity of consistence. As French brandy is not only prized for these accidental qualities, as being deemed essential to it, the English distiller designedly imitates them. The most obvious and natural method of doing this, would be by impregnating a pure spirit with the extractive, resinous, and colouring matter of oak shavings; but other modes have been contrived: thus the dulcified spirit of nitre (as it has been called), is commonly used to give it the flavour; and catechu, or burnt sugar, to impart the desired colour. A French writer has recommended for this purpose three ounces and a half of finely powdered charcoal, and four ounces and a half of ground rice, to be digested for a fortnight in a quart of malt spirit.

CHAP. VII.

ON FERMENTATION, ALCOHOL, &c.

The conditions necessary for constituting fermentation, according to M. Chaptal, are, 1. The contact or generation of pure air. 2. A certain degree of heat. 3. A quantity of water, more or less considerable, which produces a difference in the effects. The phænomena which essentially accompanies fermentation are, 1. The production of heat. 2. The absorption of oxygen gas. Fermentation may be assisted, first, by increasing the fermentable mass; the principles on which the air must act are multiplied, consequently the action of this element is facilitated: the more heat is produced by the fixation of a greater quantity of air, and consequently the fermentation is promoted by the two causes which most eminently maintain it, viz. *heat* and *air*. Two kinds of leaven may be distinguished: 1. Bodies eminently putrescible, the addition of which hastens fermentation. 2. Those which eminently abound with oxygen, and which consequently afford a greater quantity of this portion of the principle of fermentation. On this account it is, that the acids, neutral salts, and metallic calces, hasten fermentation. The products of fermentation have caused different species to be distinguished; but this variety of effects depends upon a variety of principles in the vegetable. When the *saccharine* principle predominates, the result of the fermentation is a spirituous liquor; when, on the contrary, a *mucilage* is the most abundant, the product is acid; if the *gluten* be one of the principles of the vegetable, there will be a production of ammonia in the fermentation; so that the fermentable mass may undergo different alterations, which always depend on the nature and respective properties of the constituent principles, the susceptibility of change, &c. Thus a *saccharine* liquid, after having undergone the spirituous fermentation, may be subject to the acid fermentation by the decomposition of the mucilage which had resisted the first fermentation; but in all cases, the concourse of air, water, and heat, is necessary to develope fermentation.

The term *alcohol*, strictly speaking, is only applicable to the pure spirit obtainable by distillation, and subsequent rectification from all liquids that have undergone vinous fermentation, and from none but such as are susceptible of it. But as it was commonly used, and the spirit more or less imperfectly freed from water, in the state in which it was usually met with in the shops, and in which, as it was first obtained from the juice of the grape, it was long distinguished by the name of spirit of wine. At present it is extracted chiefly from grain or molasses in Europe, and from the juice of the sugar-cane in the West Indies. In the diluted state in which it generally occurs in trade, it constitutes the basis of the several spirituous liquors called brandy, rum, gin, whisky, and even cordials, however variously denominated or disguised.

It is by the process of fermentation that the principles of alcohol are first extricated from the substances with which they were combined, and then united into a new compound. By having recourse to distillation, this new compound, the alcohol, is separated in a state of dilution with water, and contaminated with essential oil; and finally by rectification it is ultimately freed from these.

It is essential to the fermentation of alcohol, that the fermenting fluid should contain saccharine matter, indispensible to that species of fermentation called vinous. In France, where a great deal of wine is made, particularly at the commencement of the vintage, and is too weak for a saleable commodity, it is a common custom to subject this wine to distillation, in order to draw off the spirit; and as the essential oil that rises in this process is of a more pleasant flavour than that of malt or molasses, the French brandies are preferred to any other, though even in the flavour of these there is a difference, according to the wine from which they are produced.

In the West Indies, a spirit is obtained from the juice of the sugar-cane, highly impregnated with its essential oil, and well known by the name of *rum*. The distillers in this country (England) use grain or molasses, whence they distinguish the products by the name of *malt spirits*, and *molasses spirits*. It is said that a very good spirit may be extracted from the husks of gooseberries or currants, after the wine has been made from them. Rum in fact is the name given to a spirit manufactured in the West India islands, from the molasses remaining after the sugar is separated into small crystals from the boiled juice of the sugar-cane. Twelve parts of sweets are dissolved in one hundred parts of water, and fermented as completely as possible, by means of yeast, which is chiefly obtained in the distillery itself, by means of the fermentation of the rum wort, which gradually generates it. Fourteen gallons of spirits, one to ten over proof, are obtained from one hundred gallons of wash. The peculiar flavour which distinguishes rum, and makes it so agreeable to the taste, is said to be owing to an oil contained in the sugar-cane. For when spirits are made in this country from sugar, they are entirely destitute of this flavour, and resemble in their properties the common spirit made in this country by barley. The colour of rum, as it is said of French brandy, is derived from the oak casks in which it comes to this country from the islands.

Rectification.

To obtain a pure clean flavourless spirit, no attempts have been wanting on the part of the most diligent rectifiers. It has long since been observed, that rectification is an operation performed in various ways, some of which scarcely deserve the name; because, instead of freeing the spirit from its gross essential oil and phlegm, they alter the natural flavour of that which comes over, in the process. The principal business is to separate the spirit from the essential oil of the malt, &c. In order to do this, care should be taken in the first distillation, that the spirit, especially from malt or grain, should be drawn by a gentle fire, by which means great part of the essential oil will be kept from mixing with the spirit; for experience daily proves, that it is much easier to keep asunder than to separate subjects once mixed.

In order to rectify low wines, they should be put into a tall body, or alembic, and gently distilled in *balnea mariæ;* by this means a large proportion, both of oil and phlegm, will remain in the body. But if, after this operation, the spirit should be found to have too much of the essential oil, it must be let down with fair water, and gently redistilled. By this it may be brought to any degree of purity. The redundant oil may, however, be separated from proof spirit, &c. by the method already proposed, especially if it be previously filtrated through paper, thick flannel, sand, stone, &c., placing at the bottom of each, some cotton wool, for absorbing the oil that escapes the filter. But the slowness of this operation has caused many distillers to substitute caustic alkalies, which only destroy the natural flavour of the spirit. In fact, almost every distiller pretends to have some secret nostrum for rectifying his spirits ; however, they are all reducible to three, namely, by fixing alkaline salts ; by acid spirits mixed with alkaline salts, and by saline bodies, and flavouring additions.

Some distillers use quick-lime in rectifying their malt spirit, which cleanses it considerably; but if chalk, calcined and well purified animal bones, were substituted for quick-lime, the spirit would have a less alkaline, or nitrous flavour ; and consequently the flavouring ingredients might be added to it with more success, than by the other methods. Neutral salts and soluble tartar might also be used : but fine dry sugar seems best adapted for the purpose of rectifying these spirits ; as it readily unites with the essential oil, detains, and fixes it, without imparting any urinous, alkaline, or other nauseous flavour to the spirits.

CHAP. VIII.

ON MALT DISTILLING.

The Common Process.

TAKE sixty quarters of barley grist, ground low, and thirty quarters of pale malt, ground rather coarse; make your lob with ten quarters of the malt ground into coarse flour, and thirty barrels of *liquor*, at the heat of one hundred and seventy degrees; row or blend them into a uniform mass, and mix them thoroughly with the major part of the first wort, and pump them up together into the coolers; when cooled to the temperature of fifty-five degrees, they are to be let down into the fermenting-back to the reserved part of the first worts, say, thirty barrels previously pitched at sixty degrees, with ten store of fresh porter yeast, which with the rest of the worts at fifty-five degrees, altogether compose a back of distiller's wash.

Take the specific gravity of the worts previous to their descent into the backs, and before any yeast is added, and note it down in a book or table prepared for that purpose; this do every twelve hours for three or four days, during which it may be found to increase in gravity and sweetness, from the augmenting force of the fermentation; resolving the gluten, and extracting the saccharine matter. This is malting in the gyle-tun, or fermenting-back.

When the gravity seems to be stationary, or rather decreasing, a vinous tartness will begin to succeed the previous sweetness, the fermentation become more vigorous, and the gravity more rapidly decrease; before it arrives at this period, a sensible decrease of gravity, and conspicuous change of flavour, from sweet to tart, usually takes place. Closely observe every change and appearance in the fermentation, and note it down in your book.

In the course of twelve or fourteen days the yeast head will fall quite flat, which denotes the fermentation being nearly over. If the heat appears by the thermometer to drop, and the fermentation has gone on well; or if the attenuation appears by the hydrometer, to have reduced the gravity of the wash from its original weight of twenty-eight, thirty, or greater number of pounds, to two, three, or four pounds per barrel, and the wash should have a vinous odour and flavour, then all is right.

At this period some add twenty pounds of common salt, and thirty pounds of flour; rouse and keep the fermenting-back close, as it should have been during the whole process. In three or four days it will taste quite tart, and should be immediately distilled.

The officers of excise estimate six gallons of the wash to produce one gallon of spirit, at one to ten over hydrometer proof, and compute that 90 quarters of grain, yielding about 279 barrels, or 9720 gallons of wash, produce 1623 gallons of spirit, at one to ten over proof; that is, 18 gallons per quarter at that strength. This is estimating at 108 gallons, or three barrels of wash to each quarter of grain, and taking the produce of spirit at 18 gallons per quarter, as before observed.

The wash duly fermented is committed to the still; all the time it is running in, it should be roused up, or agitated in the fermenting-back by a stirring engine, to mix the thick and thin parts together into one mass, and enable it to be sufficiently fluid to flow into the still, where it is kept fluid by the stirring engine of the still, until it boils, when the agitation of the boiling usually keeps it from burning, and giving empyreumatic or burnt flavour to the *low wines;* which taint will inevitably rise from the low wines in the spirit still, during the doubling or distilling of the spirits of the second extraction.

This spirit is usually sold by weight, delivered to rectifying distillers at one to ten over proof, who rectify or distil it over again, combining it with certain ingredients in order to clarify it from its gross oil and other impurities, with the view to render it fit for making into gin, brandy, rum, and fine cordial compound.

Corn Wash.

One quarter of malt will produce about one hundred gallons of wash, and this one hundred gallons of wash when distilled, will produce about nineteen gallons of spirits, at one to ten over hydrometer proof.

Molasses Wash.

One hundred weight of sugar will produce one hundred gallons of wash, and this one hundred gallons of wash will produce from twenty-one to twenty-two gallons of spirit, at one to ten over hydrometer proof: the excise duty on this wash is one shilling and eightpence per gallon.

Method of Fermenting and Distilling Molasses in Great Britain and Ireland.

They set the backs in the former by adding two gallons of water and one of molasses; in the latter they add three of water to one gallon of molasses; to which (in both places) they add about one gallon of barm or yeast, to two hundred, and sometimes to three hundred of molasses so mixed; these they blend with a large birch-broom uniformly together: this they call setting. This must be attended to once or twice a day, and the head stirred in or more barm added occasionally, or the air partially excluded to keep it warm if it works slow, and admitted fully if it works fast.

In three days, or four at most, the backs must be *raised*, by adding (in Great Britain) two gallons of water more to each gallon of molasses *set;* and (in Ireland) the same, consequently they work their wash one-fifth stronger in Great Britain than in Ireland; and when they wish to evade the duty of excise, they work their wash still stronger; but this materially hurts the quality and quantity of the produce.

In the winter time the water added to the backs should be heated to a degree below blood warm that the backs are raised with, which may be done by heating some water scalding hot, not boiling it, in one of the stills, and drawing as much in the filling-can as will heat the remainder of the cold water to the degree wanted. When the intended portion of water is added to each back, the same proportion of barm is to be added as at setting, and all blended together with the broom: *this is termed raising.* The same, or rather more attention, must be paid after setting, and barm added if necessary.

The third stage of fermentation is cutting, which is performed four, five, or even six days after raising, but is seldom deferred so long; it is done by adding about one ounce of jalap-root, in fine powder, to every eight or ten hundred weight of molasses in summer, and about half as much more to the same quantities in winter, with the same proportion of barm as at setting and raising, which must be blended together with the barm. This is called cutting the backs; which, indeed, it very effectually does, cutting down the head or crust of flowers or barm, which the intestine motion of the fermentation threw up, and communicating a very effectual and quick fermentessence through the whole fluid mass, very distinguishable at the top of the fluid to the sight, and also to the ear, the hissing of which can now be distinctly heard. As this tumultuous motion and hissing noise lessens, the operation draws towards a conclusion; and when they can be no longer distinguished, which is generally in three or four days after cutting, the fermentation is over, and the *fermented wash* is to be emptied into the still, and the backs set anew, as before directed. This fermented wash, distilled as long as a glass of it, thrown upon the still-head, will burn or take fire from a lighted paper or candle, is called low wines, or spirits of the first extraction. These low wines are kept for three distillations, which quantity generally fills the still; which is called doubling, or second extraction, and are drawn off as before directed. This spirit, lowered with water to the hydrometer standard, is called proof spirit.

After the setting of the backs, if an addition of the barm does not bring on a sensible fermentation through the whole, a five gallon can of warm spent wash, added to every two hundred gallons of the fermenting wash, will in general bring on the desired degree of fermentation ; if not, about half the quantity of jalap usually used in cutting the backs must be added now, and the other half at cutting the backs.

In winter, particularly in frosty weather, the part of the still-house where the fermentation is going on, must be heated to the temperature of temperate on the thermometer, which will much facilitate the process. This may be done by the heat of the stills at work in winter; and the excess of heat from them in summer may be counterbalanced by windows contrived to draw a current of air across the still-house.

N. B. Dr. Franklin has observed, that the wash in a distiller's vat, when in the highest and most perfect degree of fermentation, is about the temperature of animal heat; that is, from ninety to ninety-six degrees of Fahrenheit's thermometer.

Of Feints, and their Uses.

In many of the recipes which will hereafter be given, I have ordered the receiver to be removed as soon as the feints begin to rise, as otherwise the goods would contract a disagreeable taste and smell. It is not, however, to be understood that these feints are to be thrown away, nor the working of the still immediately stopped. As soon, therefore, as you find the clear colour of the goods begin to change of a bluish or whitish colour, remove the receiver, and place another under the nose of the worm, and continue the distillation as long as the liquor running from the worm is spirituous, which may be known by pouring a little of it on the still-head, and applying a lighted candle to it; for if it is spirituous it will burn, but otherwise, not. When the feints will no longer burn on the still-head, put out the fire, and pour the feints into a cask for that purpose; and when, from repeated distillations, you have procured a sufficient quantity of those feints, let the still be charged with them almost to the top; then throw into the still four pounds of salt, and draw off as you would any other charge, as long as the spirit extracted is of sufficient strength; after which the receiver is to be removed, and the feints saved by themselves as before.

The spirits thus extracted from the feints will serve in several compositions as well as fresh; but they are generally used in aniseed cordials, because the predominant taste of the aniseeds will entirely cover what they had before acquired from other ingredients.

CHAP. IX.

FRENCH MODE OF DISTILLING AND PREPARING BRANDY.

This differs in nothing from that commonly practised in England, in the same manner as from malt wash, or molasses. They only observe more particularly, to throw a little of the natural lee into the still along with the wine, because they find this gives their spirit the flavour for which it is so generally admired. But though brandy is extracted from wine, experience tells us, that there is a great difference in the grapes from which the wine is made. Every soil, every climate, every kind of grapes, vary with regard to the quantity or quality of spirits extracted from them. Some grapes are only fit for eating; others for drying; as those of Damascus, Corinth, Provence, and Avignon, but not fit to make wine.

Some wines are proper for distillation, others less so. Those of Languedoc and Provence afford a great deal of brandy by distillation, when the operation is made in their full strength: the Orleans wine, and those of Blois, afford still more. The best wines are those of Cognac and Andaye, which, however, are among those that are the least drank in France; whereas those of Burgundy and Champagne, though of a very fine flavour, yield but very little in distillation. It must also be further observed, that all the wines for distillation, as those of Spain, the Canaries, of Alicant, Cyprus, St. Peres, Toquet, Graves, Hungary, and others, yield very little brandy by distillation, and consequently would cost the distiller considerably more than he could sell it for. What is drawn from them, however, is good, always retaining their saccharine quality and rich flavour; but as it grows old, this flavour often becomes aromatic, and is not agreeable to all palates.

Hence brandies differ as they are extracted from different sorts of grapes; nor would there be so great a similarity as there is, between the different kinds of French brandies, were the strongest wines used for distillation. But this is rarely the case; the weakest and lowest flavoured wines only, are drawn for their spirit, or such as prove absolutely unfit for any other use.

A large quantity of brandies are distilled in France during the time of the vintage; for all those poor grapes that prove unfit for wine, are usually first gathered, pressed, their juices fermented, and directly distilled. This rids their hands of the poor grapes at once, and leaves their casks empty for the reception of better. It is a general rule in France, not to distil any wine that will fetch a good price as wine; for in this state the profits upon them are much higher than when reduced to brandies.

The large stock of small wines with which they are almost over-run in France, sufficiently accounts for their making such quantities of brandy, more than in any other country, which has a warmer climate, and is better adapted to the production of grapes. Nor is this the only fund for French brandies, for all the wines that turn sharp or eager, are condemned to the still, and all such as they can neither export nor consume at home, which amounts to a large quantity, as much of that laid in for their families, is often so poor as not to keep from one season to another. Hence many English spirits, with proper management, are convertible into brandies, that in many respects, provided the operation be neatly performed, can scarcely be distinguished from the foreign. Even a cyder spirit and a crab spirit, may from the first extraction be made to resemble the fine and thin brandies of France. The art of colouring spirits owes its rise to observations on French brandies, and being found to have been derived from the oak of the cask, it is no difficulty to imitate it to perfection.

To prevent the Deterioration of Brandies.

It is certain, that when brandy is kept in vessels, the pores of which will not admit of any transmission of the liquor, as glass, for instance, the brandy will improve instead of getting worse. We have no idea of bottling off a whole store; but without much expence, we may render the hogsheads absolutely impermeable, and besides, the expence in doing this, being once undertaken, will be available for a considerable time. To effect this, a very large tub should be well hooped; two layers of oil colours then being laid on, this should be followed by a good coating of pitch and tar; this will put every idea of evaporation out of the question. In a barrel thus treated, the spirit of the brandy may be preserved three years, without the least loss, either in quantity or quality. These large tubs or reservoirs, being built into the brickwork, &c. of the store-house, may serve during a considerable lapse of time without any reparation.

On the various Methods used for the Sophistication of Brandy.

The first is performed by the addition of other fermentable matter to the must, before the fermentation has taken place, which increases the quantity in proportion to the increase of the spirit produced by the matter so added. The quantity of ardent spirit being thus augmented in order to render it wholesome, it is therefore less corrected. This kind of brandy is evidently inferior in flavour to the genuine, and in a certain degree recedes from those distilled spirits which are reckoned safe and wholesome.

Another method is by adding spirits of malt, already distilled, to the wine, or fermented must, these being the cheapest; but they must have been previously rectified for this purpose, and indeed for making any palatable spirituous liquor whatever. The depravity of this kind of brandy is still greater than the first; as it comes over in the still, nearly as so much ardent spirit mixed with the brandy; and it will of course exert its noxious qualities on those who drink it. Some persons adulterate brandy by the addition of simple rectified spirit, or by counterfeit brandy; but the far most general method is by putting a counterfeit kind to the genuine. This counterfeit brandy is made of malt spirits, first rectified, then dulcified by re-distillation of acids.

The rectification of malt spirit, in order to make brandy, is always necessary, on account of its being impregnated with a proportion of empyreumatic oil in the first distillation, which oil is commonly called the *feints.* These give a very disgusting taste and smell to the spirit distilled.

The substance much used for keeping down the feints, is a medicinal preparation, *lapis infernalis.* Its effects with the re-distillation brings the ardent spirit to that state in which it abounds with noxious qualities; and though it is freed of the feints, has a great effect upon its wholesomeness. *Lapis infernalis* is made by adding lime to pearl-ash, pot-ash, or any other vegetable alkaline salt, dissolved in water, after they have stood together some time, then drawing off the clear fluid, and evaporating it till a dry mass remain.

The acid used in the preparation of counterfeit brandy, is commonly called *spirit of nitre,* or *aqua fortis,* which, when combined with the rectified spirit, raises a flavour and taste much resembling those of brandy;

but if a certain proportion of water be mixed with such brandy, a separation of the ardent spirit and acid immediately follow; the noxious effects of these on the health of those who drink this kind of brandy, are often melancholy in the extreme.

French Brandy, from the Apples or Seed Pods of Potatoes.

For some years past, this has been made in the department of La Meurthe. The process is very simple: the apples are collected when they are perfectly ripe, and carefully bruised. The pulp is put by to ferment spontaneously. It is afterwards distilled, and one hectolitre (one hundred pounds) is usually obtained from twenty or twenty-four hundred weight of unbruised apples. The brandy is of a good flavour. It is remarkable, that the apples produce about one-tenth of their volume of alcoholic matter, while the specific gravity of the juice is no more than about one degree of the aereometer of M. Baumé. Perhaps, in this country, the addition of yeast may be necessary to promote the fermentation.

On the Strength of Brandies.

In the trade, this is judged by the phial, or by burning. The phial proof consists in agitating the spirit in a bottle, and observing the form and magnitude of the bubbles that collect round the edge of the liquor, technically termed the *beads*, which are larger or smaller, according to the strength or weakness of the spirit. These probably depend on the solution of resinous matter from the cask, which is taken up in great quantities, the stronger the spirit may be. Still various simple additions to weak spirit may produce this appearance in it. The proof by burning is also fallacious; because the magnitude of the flame, and quantity of residue in the same spirit, vary greatly with the form of the vessel it is burnt in. If the vessel be kept cool, or suffered to become hot, if it be deeper or shallower, the results will not be the same in each case. It does not follow, however, but that manufacturers and others may, in many instances, receive considerable information from these signs in circumstances exactly alike, and in the course of operations wherein it would be inconvenient to recur continually to experiments of specific gravity. The importance of this object, as well for the purposes of revenue as of commerce, induced the British government to employ Dr. Blagden, to institute a very minute and accurate series of experiments, which were published in the Philosophical Transactions for the year 1790.

The peculiar excellence and variety of French brandies, is ascribed by Mr. Morewood, in his "Essay on the Inventions and Customs of both Ancients and Moderns in the Use of Inebriating Liquors, &c. on Distillation," to the wine of every description used in that process. "Formerly (he observes), aromatic seeds and juices were made use of, but that practice has been long since abandoned.

"The general method now observed in the manufacture, differs in nothing from that practised in the distillation of malt wash or molasses in Great Britain, except that a little of the natural lees is thrown into the still along with the wine, to improve the flavour. The stills through which they run it, are made of copper, with broad bottoms, set in brick-work, with proper flues and dampers. To ascertain the strength, a small quantity of brandy at the run, is put into a very clear glass bottle of four or five inches in length, and swelled at the centre, which being well shaken, the size and stability of the bead determines the quality of the liquor, and the state of the still. But although this is the old and common practice, it is pretty certain that the hydrometer is used where great accuracy is required. The stills are worked by small pieces of wood, mostly ash; the head of the still is taken off at each time of charging, and the furnace filled with wood. The dampers are then closed, and not opened unless the fire is too dull to give it air. This requires caution; for if the fire gets strong, there is danger that the still may be burned, or the head blown off; to prevent which, cold water is thrown on the head and worm; an expedient that not only contributes to cool the still, but to deprive the liquor of its pungency."

CHAP. X.

MALT WHISKY.

The term distillation is often applied in this country, to the whole process of converting malt or other saccharine matter into spirits or alcohol.

In making malt whisky, one part of bruised malt, with from four to nine parts of barley meal, and a proportion of seeds of oats, corresponding to that of the raw grain, are infused in a mash-tun of cast iron, with from twelve to thirteen gallons of water, at 150° Fahrenheit, for every bushel of the mixed farinaceous matter. The agitation then given by manual labour or machinery to break down, and equally to diffuse the lumps of meal, constitutes the process of *mashing.* This operation continues two hours, or upwards, according to the proportion of unmalted barley; during which the temperature is kept up by the affusion of seven or eight additional gallons of water, a few degrees under the boiling temperature.

The infusion termed *wort*, having become progressively sweeter, is allowed to settle for two hours, and is run off from the top to the amount of one-third of the bulk of the water employed. About eight gallons of more water, a little under 200° Fahrenheit, are now admitted to the residuum, *infused* for nearly half an hour with agitation, and then left to subside for nearly an hour and a half, when it is drawn off. Sometimes a third affusion of boiling water, equal to the first quantity, is made, and this infusion is generally reserved to be poured on the new *farinæ;* or it is concentrated by boiling, and added to the former liquors.

To prevent acetification, it is necessary to cool the worts down to the proper fermenting temperature of 70° or 65°, as rapidly as possible. Hence they are pumped immediately from the mash-tun into extensive wooden troughs, two or three inches deep, exposed in open sheds to the cool air; or they are made to traverse the convolutions of a pipe immersed in cold water. The wort now being run into a fermenting tun, yeast is introduced, and added in nearly equal successive portions during three days, amounting in all to about one gallon for every two bushels of farinaceous matter. The temperature rises in three or four days to its maximum of 80°; and at the end of eight or twelve days, the fermentation is completed, the tuns being closed up during the last half of the period. The distillers do not collect the yeast from their fermenting tuns, but allow it to fall down, on the supposition that it enhances the quantity of alcohol.

Some years ago, when the manufacturer paid a duty for the season, merely according to the measurement of his still, it was his interest to work it off with the utmost possible speed. Hence the still and furnace contrived by some ingenious Scotch distillers, and before alluded to. Quick distillation, however, does not injure the flavour of spirits; this depending almost entirely upon the mode of conducting the previous fermentation.

In distilling off the spirit from the fermented wort or wash, a hydrometer is used to ascertain its progressive diminution of strength; and when it acquires a certain weakness, the process is stopped, by opening the stop-cock of the pipe which issues from the bottom of the still, and the spent wash is removed. There is generally introduced into the still, a bit of soap, whose oily principle spreading on the surface of the boiling liquor, breaks the large bubbles, and of course checks the tendency to froth up.

CHAP. XI.

DUTCH GENEVA.

The Dutch have long been famous for the manufacture of an excellent kind of spirits, known in England by the name of *Hollands*. A gentleman some years ago went over to Holland, on purpose to make himself acquainted with the process, with a view of introducing it into Scotland. But the severe laws by which the Scotch distillers were soon after bound, put it out of his power to execute his plan. The Dutch, he observed, mash 112 pounds of barley malt, and 228 pounds of rye meal, together with 460 gallons of water, of the temperature of 162°. After the infusion has stood a sufficient time, cold water is added, till the strength of the wort is reduced to forty-five pounds per barrel. The whole is then put into a fermenting back, at the temperature of 80°. The vessel is capable of holding about 500 gallons. Half a gallon of yeast is added. The temperature rises to 90°; and the fermentation is over in forty-eight hours. The attenuation is such, that the strength of the wash is not reduced lower than fifteen pounds per barrel.

The experiment of manufacturing Hollands gin in this country, has been tried at Maidstone by a Mr. Bishop, who had interest enough with Mr. Pitt to get a special clause inserted in the act passed for this purpose; however, the manufactory was never successful. The Maidstone Hollands never acquired much reputation; the concern languished some years, and then terminated in a bankruptcy. Some attempts to revive it have however been made.

The following has been given as the Dutch method of making Geneva: one hundred weight of barley malt, and two of rye meal, are mashed with 460 gallons of water, heated to 162° Fahrenheit. After the *farinæ* have been infused for a sufficient time, cold water is to be added, till the wort becomes equivalent to forty-five pounds of saccharine matter per barrel. Into a vessel of 500 gallons capacity, the wort is now to be put, at the temperature of 80°, with half a gallon of yeast. The fermentation instantly begins, and is finished in forty-eight hours, during which the heat rises to 90°. The wash, not reduced lower than twelve or fifteen pounds per barrel, is put into the still along with the grains. Three distillations are required; and at the last a few juniper berries and hops are introduced, to communicate a flavour. The attenuation of forty-five pounds in the wort, to only fifteen in the wash, shews that the fermentation is here very imperfect and uneconomical; as indeed we might infer from the small proportion of yeast, and the precipitancy of the process of fermentation. On the other hand, the very large proportion of the porter yeast, in a corrupting state, used by the Scotch distillers, cannot fail to injure the flavour of their spirits.

The finest Hollands geneva is said to be made in Holland from a spirit drawn from wheat, mixed with a third or fourth part of malted barley, and twice rectified over juniper berries; but in general, rye meal is used instead of wheat. They pay so much regard to the water employed, that many distillers send vessels to the Meuse on purpose to fetch it; but all use the softest and clearest river water they can get. In England, it is the common practice to add oil of turpentine, in the proportion of two ounces to ten gallons of raw spirit, with three handfuls of bay salt, and these to be drawn off till the feints begin to rise.

Corn, or spirit of molasses, is also flavoured by a variety of aromatics, with or without sugar, to please different palates; all of which are included under the technical term of *compounds*, or *cordials*. Other articles have been employed for the fabrication of spirit, though not commonly; for instance, carrots and potatoes. Professor Proust says, that from the fruit of the carob tree, he has obtained good brandy, in the proportion of a pint from five pounds of the dried fruit.

To obtain pure alcohol, different processes have been recommended; but the purest rectified spirit, obtained as above described, being least contaminated with foreign matter, should be preferred. Rouelle recommends the drawing off half the spirit in a water bath; then to rectify this twice more, drawing off two-thirds each time: to add water to this alcohol, which will turn it milky, by separating the essential oil remaining in it; to distil the spirit from this water, and finally rectify it by one more distillation.

Baumé, another French writer, sets apart the first running when about one-fourth is come over, and continues the distillation till he has drawn off about as much more, or till the liquor runs off milky. The last running he puts into the still again, and mixes the first half of what comes over with the preceding first product. This process he repeats again, when all the first products mixed together are distilled afresh. When about half the liquor is come over, this is to be set apart as pure alcohol.

Alcohol in this state, notwithstanding, is not so pure as when, using the language of the old chemists, it has been *dephlegmated*, or still further freed from water, by means of some alkaline salt. Boerhaave recommended for this purpose the muriate of soda, deprived of its water of crystallization by heat, and added hot to the spirit; but the subcarbonate of pot-ash is preferable. About a third of the weight of the alcohol should be added to it in a glass vessel well shaken, and then suffered to subside. The salt will be moistened by the water absorbed from the alcohol; which being decanted, more of the salt is to be added; and this is to be continued till the salt falls dry to the bottom of the vessel. The alcohol in this state will be reddened by a portion of the pure pot-ash, which it will hold in solution, from which it must be freed by distillation in a water bath. Dry muriate of lime may be substituted advantageously for the alkali.

Lastly, as alcohol is much lighter than water, its specific gravity is adopted as the test of its purity. Fourcroy considers it as rectified to the highest point, when its specific gravity is 829, that of water being 1000; and perhaps this is as far as it can be carried by the process of Rouelle, or Baumé, simply.

To determine the Strength or relative Value of Spirits.

Before this can be well done, the following requisites must be obtained; the specific gravity of a certain number of mixtures of alcohol and water, must be taken so near each other, as that the intermediate specific gravities may perceptibly differ from those deduced from the supposition of a mere mixture of the fluids; the expansions or variations of specific gravity in these mixtures must be determined at different temperatures; some easy method must be contrived for determining the presence and quantity of saccharine or oleagenous matter which the spirit may hold in solution, and the effect of such solution on the specific gravity; and lastly, the specific gravity of the fluid, must be ascertained by a proper floating instrument, with a graduated stem, or set of weights, or which may be more convenient, with both.

Brewing for Hollands Gin.

Their grist is composed of ten quarters of malt, ground considerably finer than our malt distillers' barley grist, and three quarters of rye meal; or, more frequently, of ten quarters of rye, and three quarters of malt meal. The ten quarters are *first mashed* with the least quantity of cold water it is possible to blend it up with; when uniformly incorporated, as much boiling water is added as forms it into a thin bitter; it is then put into one, two, or more casks, or gyle tuns, with a much less quantity of yeast than is usually employed by our own distillers. Generally on the third day they add the malt or rye meal, previously made into a kind of lob, prepared in similar manner, except in not being so much diluted; but not before it comes to the temperature of the fermenting wash; at the same time adding full as much yeast as when at first *setting* the backs.

The principal secret in the management of the mashing part of the business is, in first thoroughly mixing the malt with the cold water, that it may still remain sufficiently thin after the addition of the fine meal, under the form of lob, and in well rousing all together in the back, that the wash may be sufficiently diluted for distilling, without endangering its burning to the bottom of the still. Thus they commodiously reduce the business of brewing and fermenting to one operation. By uniformly using cold water to wet the malt, all danger of clogging the spending of the tap would be necessarily avoided; but here, there is no occasion to do any thing more than to dilute the wash, consisting of the whole of the grain, thin enough to be fermented and distilled together, by which means the spirit of the bran and husky part, as well as of the flour of the grain, are completely extracted; yet their wash, compared to ours, is about three-eighths thinner.

For these reasons, they obtain more spirit from their grain than we do, and of a better quality, with not half the trouble taken by our distiller. Their backs usually contain as much wash as serves for one distillation.

The gravity of the distillers' wash at Weesoppe, in the neighbourhood of Amsterdam, in 1804, weighed but eighteen pounds per barrel, very little more than half the gravity of ours. Their stills usually are from three to five hundred gallons each: they constantly draw off three cans of phlegm, after the runnings cease to burn on the head of the still, when distilling wash; and five cans distilling *low wines;* a practice we are unacquainted with, we usually drawing our fire as soon as the runnings from the still burn languidly on the still-head.

This, and the great quantity of rye they use, causes their spirit to be so much more acid; and the diluteness of their wash is a very good reason for the greater purity of their spirit; though most writers mistakenly say, our spirit is much clearer.

Rectification into Hollands Gin.

To every twenty gallons of spirits of the second extraction, about the strength of proof spirit, take three pounds of juniper berries, and two ounces of oil juniper, and distil with a slow fire until the feints begin to rise, then change the receiving can; this produces the best Rotterdam gin. An inferior kind is made with a still less proportion of berries, sweet fennel seeds and Strasburgh turpentine, without a drop of juniper oil. It, and a better sort, but inferior to the Rotterdam gin, are made at Weesoppe.

The distillers' wash at Schiedam and Rotterdam are still lighter than at Weesoppe. Strasburgh turpentine is of a yellowish brown colour, and very fragrant agreeable smell, its taste is the bitterest, yet the least acid of the turpentines. The juniper berries are so very cheap in Holland, that they must have more reasons than mere cheapness for being so much more sparing of their consumption than our distillers. Indeed they are not in the habit of wasting any thing.

Mr. Morewood thus describes two principal modes observed in preparing the wash for geneva in Holland: "A quantity of flour of rye, coarsely ground, is mixed with a third or fourth part of barley malt proportioned to the size of the tub in which the vinous fermentation is to be effected. This they mix with cold water, and then stir it with the hand, to prevent the flour from gathering into lumps, and to facilitate its dissolution. When this point is attained, water is added, of the heat of the human blood. The whole is well stirred, after which the ferment is mixed with the wort, being previously diluted with a little of the liquor. The fermentation generally begins six hours afterwards; if it commence earlier, there is reason to apprehend it will be too strong, and means are employed to check it. If the fermentation be well conducted, it generally terminates on the third day, when the liquor grows transparent, and assumes an acrid taste, hot and biting on the tongue. The wash is then well roused, and the mash with all the corn, is put into the still, and then commences the first distillation, which is conducted very slowly, which is a matter of the utmost importance. This liquor is then rectified over juniper berries once or twice, according to the sort of spirit which it is intended to produce. For common use one rectification is deemed sufficient, though it is not considered so fine, pleasant, or delicate, as that which has undergone several rectifications, and which is called double geneva. Some distillers mix the juniper berries with the wort, and ferment them together, but in that case they only draw a spirit from it for the use of the interior, or for exportation to England; the juniper, however, is most commonly used at the rectification, and not before.

" In the second method pursued by the best distillers, the malt and rye are mixed with warm water in given proportions, and thoroughly blended together until all the farinaceous substance is incorporated; the liquid is then allowed to rest until the flour has settled at the bottom. The wort is afterwards permitted to flow into the fermenting tub, where a similar operation takes place with another quantity of water poured upon the same grain, and these operations are repeated until the wort thus drawn from it at different times has abstracted the whole saccharine matter into the flour. This liquid is put into the fermenting tun or vessel, and when it comes to the proper temperature, about blood heat, the ferment, or yeast, is added. The fermentation is considered more mild and regular by this method than the other. Some pour all the water they intend to use into the tub or kieve, at once, and put the flour gently into it, while two or more persons are employed in stirring it with sticks, made for that purpose, to mix the flour, and to prevent it from gathering into lumps; when the whole of it is properly reduced and mixed together, they proceed to draw it off into a cooler before it is put into the fermenting vessel. In all cases, the gravity of the worts is low, seldom exceeding forty; and by distilling from a mixture of wash and grains, the produce is allowed to be much greater than that obtained in Great Britain from potatoe alone."

Recipe for making Ten Gallons of Royal Geneva by Distillation.

Take of juniper berries, three pounds; proof spirits, ten gallons; water, four gallons. Draw off by a gentle fire till the feints begin to rise, and make up your goods to the strength required with clean water. The distillers generally call those goods which are made up proof, by the name of *royal.*

Common Gin by Distillation.

Take of ordinary malt spirits, ten gallons; oil of turpentine, two ounces; juniper berries, one pound; sweet fennel and caraway seeds, of each four handfuls; bay salt, three handfuls. Draw off by a gentle fire till the feints begin to rise, and make up your goods to the strength required. Say, ten gallons of spirit will make about fifteen gallons of common gin.

CHAP. XII.

SUGAR SPIRIT, AND VARIOUS PROCESSES.

By a sugar spirit, is meant that spirit extracted from the washings, skimmings, dross, and waste of the boiling-house.

These drossy parts of the sugar are to be diluted with water, fermented in the same manner as molasses or wash, and then distilled in the common method. And if the operation be carefully performed, and the spirit well rectified, it may be mixed with foreign brandies, and even Cognac in a large proportion, to great advantage; for this spirit will be found superior to that extracted from treacle, and consequently more proper for these uses. In Barbadoes, a very good spirit of this kind is prepared from the cane juice, called cane spirit, resembling very pure rum.

Raisin Spirits.

By raisin spirit, we understand that extracted from raisins, after a proper fermentation.

In order to extract this spirit, the raisins must be infused in a proper quantity of water, and fermented.

When the fermentation is completed, the whole is to be thrown into the still, and spirits extracted by a strong fire.

The reason why we here direct a strong fire, is, because by that means a greater quantity of the essential oil will come over the helm with the spirit, which will render it much fitter for the distiller's purpose; for this spirit is generally used to mix with common malt goods: and it is surprising how far it will go in this respect, ten gallons of it being often sufficient to give a determining flavour, and agreeable vinosity to a whole piece of malt spirit.

N. B. In the same manner a spirit may be obtained from cider. But its particular flavour is not so desirable as that obtained from raisins.

Preparation of Rum in the West Indies.

In the still-house as well as the boiling-house, the greatest cleanliness is necessary; the vats at the beginning of the crop ought to be well washed out, both with warm and cold water, to divest them of any sour stuff which may have accumulated or adhered to their bottoms and sides, since they were last in use; and if every vat, just before the first setting, or mixing the liquor in it, were to be rinsed with a little rum, the distiller would be amply repaid for this trifling expence and trouble.

In setting the first round of liquor, a greater proportion of skimming from the sugar-pans must be used than will afterwards be necessary, as the distiller has no good *lees*, and very little *molasses*, to add to the mass; and besides, the skimmings at this time are not so rich as they will be some time hence; in March, April, or May, which are esteemed the best yielding months. The following proportions will succeed well in the beginning: for every one hundred gallons your vat contains, put forty-five gallons of skimmings, and five gallons of *molasses*, to fifty gallons of water.

When you have got good *lees*, or *returns*, as they are commonly called, mix equal quantities of *skimmings*, *lees*, and water, and for every one hundred gallons, add ten gallons of molasses.

When the mill is going, and therefore you have no *skimmings*, mix equal parts of *lees* and water, and for every hundred gallons, add twenty gallons of *molasses*.

From liquor set in these proportions, the distiller may expect to obtain from *ten* to *fifteen* per cent of Leeward Islands proof rum, and twice as much *low wines*.—But the quantity of spirit will depend greatly on the quality of the ingredients, and in some measure on the weather; therefore an intelligent distiller will vary his proportions accordingly.

The Distillation of Rum in the West Indies.

Rum differs from what we simply call sugar spirit, as it contains more of the natural flavour, or essential oil of the sugar-cane; a great deal of raw juice, and even parts of the cane itself, being often fermented in the liquor, or solution of which the rum is prepared.

From hence it is generally thought, that the rum derives its flavour from the cane itself.

Some, indeed, are of opinion, that the oily flavour of the rum proceeds from the large quantity of fat used in boiling the sugar.

This fat, indeed, if coarse, will give a rancid flavour to the spirit in our distillations of the sugar liquor, or wash, from our refining sugar-houses at home; but this is nothing like the flavour of rum.

Great quantities of rum are made at Jamaica, Barbadoes, Antigua, and other sugar islands. The method of making it is this: when a sufficient stock of materials is got together, they add water to them, and ferment them in the common method, though the fermentation is always carried on very slowly at first; because, at the beginning of the season for making rum in the islands, they want yeast to make it work; but after this, they, by degrees, procure a sufficient quantity of the ferment, which arises up as a head to the liquor in the operation; and thus they are able afterwards to ferment, and make their rum with a great deal of expedition, and in very large quantities.

When the wash is fully fermented, or to a due degree of acidity, the distillation is carried on in the common way, and the spirit is made up proof, though sometimes it is reduced to a much greater degree of strength, nearly approaching to that of alcohol, or spirits of wine; and it is then called double distilled rum.

It would be easy to rectify the spirit, and bring it to a much greater degree of purity than we usually find it to be of, if it did not bring over in the distillation so large a quantity of the gross oil, which is often so disagreeable, that the rum must be suffered to lie by a long time to mellow, before it can be used; whereas, if well rectified, its flavour would be much less, and consequently much more agreeable to the palate.

The best state to keep rum, both for exportation and other uses, is doubtless in that of alcohol, or rectified spirits. In this manner, it would be contained in half the bulk it usually is, and might be let down to the common proof strength with water, when necessary.

To make up Rum, Brandy, and Hollands Gin.

On the arrival of the West India fleets, it is usual for dealers in spirits to purchase large quantities of rum from the importers at once, and acquaint their correspondents therewith, and the price they then bear; part of the rums are bonded, and the remainder taken home. Preparation being made for their reception, the above rums are carted home, and started into a back or a large vessel, the over proof reduced with water. They are now well rummaged, and further reduced, suppose we say to one in ten under proof, which is a good mercantile strength. In purchasing rums, you may have some from Barbadoes, Antigua, and other sugar plantations, as well as Jamaica; for it cannot be supposed that Jamaica can supply all the country with rums; therefore by mixing the different rums together, and letting them remain in the aforesaid back till they are wanted, will greatly mellow and improve their flavour.

Having given the process, it is necessary to demonstrate clearly what each puncheon stands you in.

Made up Rum.

Jamaica rum 100 gallons, one to three and four per cent.			
The per cents 37 reduced			
137 gallons of proof spirits, at 18s. per gallon . . .	£123	0	0
17 further reduced to 1 in 10			
154 gallons, 1 in 10 under proof, at 19s. per gallon	146	0	0
Bought at first cost	123	0	0
	£23	6	0

It appears by this calculation, there is a profit on each puncheon, of 23*l.* 6*s.* From this sum, the various expences and losses must be deducted, and the remainder will be the distiller's profit.

The above calculations will answer for brandy and Hollands geneva, and you can make them up to any strength, but not under one in six.

To make British Brandy.

To sixty gallons of clean rectified spirits, put one pound of sweet spirit of nitre, one pound of cassia buds, ground, one pound of bitter almond meal (cassia and almond meal to be mixed together before they are put to the spirits), two ounces of orris root, sliced (not powdered), and about thirty or forty prune stones, pounded; rummage them all well together two or three times a day, for three days or more; let them settle, then add one gallon of the best wine vinegar, and if you wish to have it better than British brandy is in common, add to every four gallons, one gallon of foreign brandy, which will make it nearly equal to foreign itself.

To make an Artificial Proof.

To make an artificial proof for spirits, take pearl-ashes, a quarter of a pound; pot-ashes, ditto; soper's lye-water, three quarts; one ounce of the oil of vitriol; one pint of the oil of almonds; lime-water, one gallon; add a little of this mixture to your goods, by degrees, till you find it carries a good head.

Notwithstanding I have given this recipe, I do not recommend any person in the spirit trade to make use of it.

To make a Four Gallon Cask of Lime-Water.

Take eight pounds of unslacked lime, put it into a pail or tub, and pour on it three quarts of water to dissolve it; in about an hour after, add three gallons more of water, and let it stand for twenty-four hours, then pour the fine off into your four gallon cask, and put a cock in it, and it is always ready for use.

Some may think lime-water is very unwholesome, but it is quite the contrary; it is much used in medicine, and the distillers wash their back with it.

The Vitriolic Liquor, or Ether.

Take of rectified spirit of wine, oil of vitriol, of each thirty-two ounces; pour the spirit into a glass retort that will bear the sudden heat, and pour the acid at once upon it; mix them gradually and cautiously together, by gently shaking the retort; and immediately distil, by a sand heat, prepared before-hand for that purpose, the recipient being placed in a vessel of snow or water. The fire should be so regulated, that the liquor may boil as soon as possible, and continue to boil till sixteen ounces are distilled, when the retort is to be removed.

To the distilled liquor add two drachms of the stronger common caustic, and distil again, from a very high retort, with a very gentle fire, the recipient being placed as before in a refrigeratory. Continue the distillation till ten ounces are drawn off.

To the acid residuum, after the distillation, if you pour sixteen ounces of rectified spirit of wine, and repeat the distillation, more ethereal liquor may be obtained, and this process may be repeated several times.

The preparation of this singular fluid has hitherto been confined to few hands; for though several processes have been published for obtaining it, the success of most of them is precarious, and some of them are accompanied with danger to the operator. Where the dulcified spirit only is the object, the method, as before directed for it, succeeds to perfection; but when it is made with a view to the other, a variation is necessary, for only a small quantity of ether can be separated from the spirit so prepared; there, the distillation is performed with an equable and gentle heat; here, the fire should be hastily raised, so as to make the liquor boil; for on this circumstance the produce of ether principally depends.

Ether is the lightest, most volatile, and inflammable of all known liquids. It is lighter than the most highly rectified spirit of wine, in proportion of about seven to eight. A drop let fall on the hand, evaporates almost in an instant, scarcely rendering the part moist. It does not mix, but only in a small quantity, with water, spirit of wine, alkaline lixivia, volatile alkaline spirits, or acids; but is a powerful dissolvent for oils, balsams, resins, and other analogous substances. It has a fragrant odour, which, in consequence of the volatility of the fluid, is diffused through a large space. Its medical virtues are not as yet much known, though it is not to be doubted that a fluid of so much subtilty must have considerable effects. It has often been found to give ease in violent head-achs, by being applied externally to the part, and to relieve the tooth-ach, by being laid on the afflicted jaw. It has been given also internally, with benefit, in hooping coughs and hysterical cases, from two or three drops to five and twenty, in a glass of wine or water, which should be swallowed as quick as possible, as the ether so speedily exhales.

Dulcified Spirit of Nitre.

Take of rectified spirit of wine, three pounds; nitrous acid, one pound; pour the rectified spirit of wine into a large bolt head, placed in a vessel of cold water, and add, by degrees, the acid, carefully shaking the vessel; set it in a cool place, lightly stopped, for seven days; afterwards distil the liquor in a water-bath, the receiver being placed in a vessel filled either with water or snow, as long as any spirit arises.

Here the operator must take care not to invert the order of mixing the two liquors, by pouring the vinous spirit into the acid; for if he should, a violent effervescence and heat would ensue, and the matter be dispersed in highly noxious red fumes. The most convenient and safe method of performing the mixture seems to be, to put the inflammable spirit into a glass body, with a narrow mouth, placed under a chimney, and to pour the acid upon it, by means of a glass funnel, in very small quantities at a time, shaking the vessel as soon as the effervescence ensuing upon each addition ceases, before a fresh quantity is put in. By these means the glass will be heated equally, and be prevented from breaking. During the action of the two spirits upon one another, the vessel should be lightly covered; if close stopped, it will burst, and if left entirely open, some of the more valuable parts will exhale. Lemery directs the mixture to be made in an open vessel, by which unscientifical procedure he usually lost, as he himself observes, half his liquor: and we may presume that the remainder was not the medicine here intended.

Dulcified spirit of nitre has been long held, and not undeservedly, in great esteem. It quenches thirst, promotes the natural secretions, expels flatulencies, and moderately strengthens the stomach. It may be given from twenty drops to a drachm, in water, tea, or wine. Mixed with a small quantity of spirit of hartshorn, the spirituous volatilis aromaticus, or any other alkaline spirit, it proves a mild, yet efficacious, diaphoretic, and often notably diuretic; especially in some febrile cases, where such a salutary evacuation is wanted. *A small proportion of this spirit, added to malt spirits, gives them a flavour approaching to that of French brandy.*

The Qualities of Rectified Spirit of Wine.

We have seen that these spirits, from whatever vegetable subjects they have been produced, are, when perfectly pure, the same. They have a hot pungent taste, without any particular flavour; they readily catch flame, and burn entirely away, without leaving any marks of an aqueous moisture behind; distilled by a heat less than that of boiling water, they totally arise, the last runnings proving as flavourless and inflammable as the first: they dissolve essential vegetable oils and resins into an uniform transparent fluid.

The spirits are the lightest of almost all known liquors; expressed oils, which swim upon water, sink in these to the bottom; a measure which contains ten ounces by weight of water, will hold little more than eight and a quarter of pure spirit. The uses of vinous spirits, as menstrua for the virtues of other medicines, we have seen, and in this place consider only their own.

Pure alcohol coagulates all the fluids of animal bodies, except urine, and hardens the solid parts; applied externally, it strengthens the vessels, thickens the juices in them, and thus powerfully restrains hæmorrhages. It instantly contracts the extremities of the nerves it touches, and deprives them of sense and motion, by these means easing them of pain, but at the same time destroying their use. Hence employing spirituous liquors in fomentation (notwithstanding the the specious titles of vivifying, heating, restoring mobility, resolving, dissipating, and the like, usually attributed to them) may sometimes be attended with unhappy consequences. These liquors received undiluted into the stomach, produce the same effects, thickening the fluid and contracting all the solid parts which they touch, and destroying, at least for a time, their use and office: if the quantity be considerable, a palsy or apoplexy follows, which ends in death. Taken in a small quantity, and duly diluted, they brace up the fibres, raise the spirits, and promote agility; if further continued, the senses are disordered, voluntary motion destroyed, and at length the same inconveniences brought on as before. Vinous spirits, therefore, in small quantities, and properly diluted, may be applied to useful purposes in the cure of diseases; whilst in larger ones, or if their use be long continued, they act as a poison of a particular kind.

CHAP. XIII.

ON THE FLAVOURING OF SPIRITS.

As the rectification of spirits from alkaline salts destroys their vinosity, and introduces an urinous or lixivious taste, several methods have been proposed, and a multitude of experiments performed, in order to discover this great *desideratum*, but hitherto without success, none having succeeded equal to the *spirit of nitre*, and accordingly this spirit, either strong or dulcified, has been used by most distillers, to give an agreeable vinosity to their spirits.

With respect to the colouring of spirits, that of French brandy has been held up as the acme of perfection; the extract of oak has been proposed; but after all, the most practicable means, found by experience, is the use of common treacle and burnt sugar, though it has been said that neither of these will succeed when put to the test of the vitriolic solution.

Of the Use of Juniper Berries.

Various are the kinds of berries used in England, and mostly imported from Germany; but if you make use of English berries, let them be fully ripe before they are gathered; and to preserve them, spread them very thin on a boarded floor, leaving the windows and doors open: turn them once a day till they are dry; after which pack them up in barrels, to exclude the air, and they will keep good all the year. Some persons, when they are dry, throw them altogether in a corner, till wanted for use; but treated in this way, they are apt to get mouldy, and give a bad taste to the goods.

Other distillers, as soon as their berries are gathered, put them into casks, and cover them with spirits of wine; this way the berries are well preserved; but unfortunately the spirit will extract a great deal of their essential oil. If this method is adopted, you should put into each cask or jar, only the quantity used for one charge of the still; but upon occasion, both the spirits and berries may be put into the alembic. Thus the berries will be finely preserved without any loss of their essential oil, or the spirits made use of to assist in the operation. Among the various kinds of juniper berries, the Italian, have been denominated *rank;* the German, *sweet;* the Trieste, *middling sweet;* the French, *rank.*

To obtain a pure flavourless Spirit from Potatoes.

This may also be produced from several other vegetables of the edible kind, as carrots, parsnips, beet-roots, &c. With respect to other plants found out by philosophical men, particularly *French*, it may be necessary to make an experiment for ascertaining the quantity of saccharine matter they contain, in order that the amount of the incidental labour, and the expence of materials, may be computed. This may be effected, by making a tincture of the vegetable to be assayed, in *rectified spirits of wine*, which, when saturated by heat, will deposit the sugar, upon standing in the cold.

To make Ten Gallons of Gin Bitters.

Take ten gallons of common gin, spirits of wine half a pint, in which dissolve the following essential oils with the assistance of a little well dried loaf sugar, finely powdered, viz. essence of lemon and orange-peel, of each an ounce; oil of wormwood, a quarter of an ounce; orange-peel dried, one pound; let them digest without heat for fourteen or fifteen days, then draw off for use as wanted; taking care not to disturb the goods, by stirring the vessel they are made in.

This will be a most pleasant cheap bitter, equally wholesome, and as good as many that are much dearer.

This is only fit to be taken with gin. The same ingredients, and rectified malt spirits, or molasses spirits, will either of them make a bitter of more general use.

COMPOUNDS PREPARED WITHOUT DISTILLATION.

For making from 120 *to* 130 *Gallons of Rum Shrub.*

Take sixty-five or seventy gallons of rum, one in eight; from seven to eight gallons of lemon-juice; from six to seven gallons of orange-juice; both fresh expressed from the fruit; orange-wine, thirty gallons; two pounds of the rind of fresh lemon-peel; and one pound of the rind of fresh orange-peel; both pared off as thin as it can be done, and previously steeped for a few days in the rum; one hundred pounds of loaf-sugar. Fill up the cask of 120 gallons, or 130 gallons, with fair water; rouse them well together; if not sweet enough, sweeten to your palate; if too sweet, add more lemon-juice. Dissolve your sugar in part of the water used for making up your shrub; let it stand till fine, set up on end, with a cock near the bottom.

For making 130 *Gallons of Brandy Shrub.*

Take from seventy-five to eighty gallons of brandy; eight to ten gallons of lemon-juice;

eight gallons of orange-juice; four pounds of thin rind of fresh orange-peel and two pounds of fresh lemon-peel, both pared as thin as they can be; and add them to the brandy the first thing; with four ounces of terra-japonica; one hundred weight of loaf or clayed sugar, dissolved in part of the water used for making up, added with the above ingredients to the brandy, &c.; fill up with fair water, set the cask on end, with a cock near the bottom, and let it stand till fine.

Shrub may be made in similar manner with British rum or brandy, or with a pure flavourless spirit, prepared from molasses or grain, with similar ingredients in the before-mentioned proportions. The quantity can be increased or reduced at pleasure, by duly apportioning the ingredients to the quantity of spirits employed. For instance:

To make Two Gallons of Rum Shrub.

Take one gallon of rum, at one in eight; of lemon and orange juice, each one pint; one quart of orange wine; and two pounds of loaf sugar; one orange and lemon peel;

and fill up your two gallon vessel with water, cork it up loosely, and let it stand until fine, then cork it down close.

To make Two Gallons of Brandy Shrub.

Take one gallon and a pint of brandy, one in eight; lemon and orange juice, of each a pint; four orange and two lemon peels; sugar, two pounds; compound essence of orange and lemon-peel, a small tea-spoonful; make up with fair water, and let it stand till fine. Be careful in drawing it off not to shake the vessel.

To make Twenty Gallons of Peppermint Cordial.

Take thirteen gallons of rectified spirits, one in five under hydrometer proof; twelve pounds of loaf sugar; one pint of spirit of wine that will fire gunpowder; fifteen pennyweights, Troy, of oil of peppermint; water, as much as will fill up the cask, which should be set up on end, after the whole being well roused, and a cock for drawing off placed in it.

To make up the above.

Powder two or three ounces of sugar in a brass mortar, on which pour the oil of peppermint, and beat it into a thin paste, stirring the sugar and oil with a knife, scraping what is in the pestle and mortar together, that the oil may be uniformly incorporated with the sugar; then add the spirit of wine, and blend them well together; have the remainder of your sugar ready dissolved in four or five gallons of the water to be used for making up; rummage, or rouse, the whole well together with a paddle-staff, or rouser; dissolve one ounce and a half of powdered alum in the making up water, boiling over the fire; and when blood warm, add it to fill up the cask, in which place a cock, and let it stand two or three days, in which time it will be fit for use.

If the essential oil is of your own making, or such as you can depend on, it will require nothing more than agitation.

To make Twenty Gallons of Aniseed Cordial.

Take fourteen gallons of spirits, one in six; a pint of spirit of wine, strong as in the former cordial; from six to eight pounds of loaf sugar; one ounce and an half of oil of aniseed; two ounces of finely powdered alum; dissolve the sugar in one part of the water used for making up, and your alum in the remainder; and proceed as directed in the making up peppermint cordial. Aniseed cordial does not bear to be reduced much below one in five, as part of the oil will separate when too much lowered, and render the goods unsightly.

To make Two Gallons of Noyau.

One gallon and an half of French brandy, one in five; six ounces of the best fresh prunes; two ounces of celery; three ounces of the kernels of apricots, nectarines, and peaches; and one ounce of bitter almonds; all gently bruised; essence of orange-peel, and essence of lemon-peel, of each two pennyweights, killed in the same manner as the oil of peppermint; half a pound of loaf sugar; let the whole stand ten days or a fortnight; then draw off, and add to the clear noyau as much rose water as will make it up to two gallons, which will be about half a gallon.

To make Two Gallons of Cinnamon Cordial.

Take two pennyweights of oil of cassia-lignea, killed as before mentioned, with sugar and spirits of wine; a gallon and an half, at one in six; cardamom seeds, husked, an ounce; orange and lemon-peel dried, of each an ounce; fine with half a pint of alum water; sweeten to your palate with loaf sugar, not exceeding two pounds, and make up two gallons measure with the water you dissolve the sugar in. This is a very cheap and elegant cinnamon cordial; colour with burnt sugar.

To make Twenty Gallons of Caraway Cordial.

Take an ounce and an half of oil of caraway; twenty drops of cassia-lignea oil, and five drops of essence of orange-peel, and the same quantity of the essence of lemon; thirteen gallons of spirits, one in five; eight pounds of loaf sugar; make it up and fine it down, as directed for aniseed.

To make Twenty Gallons of Citron Cordial.

Infuse fourteen pounds of Smyrna figs, for a week, in twelve gallons of spirits, one in five; draw off, and add to the clear spirituous infusion essence of orange and lemon, of each an ounce, killed in a pint of spirits of wine; half a pound of dried lemon, and four ounces of orange-peel; six or seven pounds of loaf sugar: make up as before, with fair water.

To make Twenty Gallons of Imperial Ratafia.

In these kingdoms the most compendious way of making the best ratafia is, by taking three quarters of a pound of the kernels of peaches, nectarines, and apricots, bruised; three pounds of bitter almonds, bruised; half a gallon of rectified spirit of wine, in which dissolve half an ounce of compound essence of ambergris; twelve gallons of pure molasses spirit, one in four gallons of British Frontiniac wine; and as many gallons of rose water as will make up the ratafia to twenty gallons; steep the kernels and almonds for ten days, then draw off for use. This quantity will take ten pounds of loaf sugar to sweeten it; but as some may not like it so, it had better be sweetened by a few gallons at a time, as it may be wanted.

Recipe for making Red Ratafia.

Take of cherries and gooseberries, of each thirty pounds; mulberries, seven pounds; raspberries, ten ponnds. Pick all these fruits clean from their stalks, &c., bruise them, and let them stand twelve hours; but do not suffer them to ferment. Press out the juice, and to every pint add three ounces of sugar; when the sugar is dissolved, run it through the filtering bag, and to every five pints of liquor add four pints of clean proof spirit; together with the same proportion of spirit drawn from spices.

Different distillers use different quantities of the spirit drawn from spices. The best method, therefore, is to imitate the flavour most universally approved of, which may be easily done, by adding a greater or less proportion of the spiced spirit.

To make the Spicy Spirit.

Take of mace, one pound; nutmegs, four ounces; spirit, three gallons; and draw off the whole in *balneum mariæ*.

Lovage Cordial, Twenty Gallons.

Take of the fresh roots of lovage, valerian, and celery, and sweet fennel, each four ounces; of essential oil of caraway and savin, each one ounce; spirit of wine, one pint; twelve gallons of proof spirits; loaf sugar, twelve pounds; steep the roots and seeds in the spirits fourteen days; and kill, or dissolve, the oils in the spirit of wine, and add them to the undulcified cordial drawn off from the other ingredients; dissolve the sugar in the water for making up; fine, if necessary, with alum.

Nectar, a Twenty Gallon Cask,

May be made with fifteen gallons of the imperial ratafia, a quarter of an ounce of cassia oil, and an equal quantity of the oil of caraway seeds, dissolved in half a pint of spirit of wine, and made up with orange wine, so as to fill up the cask.

Sweeten, if wanted, by adding a small lump of sugar in the glass.

Ten Gallons of Common Usquebaugh by Distillation.

Usquebaugh is a very celebrated cordial, the basis of which is saffron.

There are different ways of making this famous Irish cordial, as:

Take of nutmegs, cloves, and cinnamon, of each two ounces; of the seeds of anise, caraway, and coriander, each four ounces; liquorice root, sliced, half a pound; bruise the seeds and spices, and put them together with the liquorice into the still, with eleven gallons of proof spirits, and two gallons of water; distil with a pretty brisk fire till the feints begin to rise. But as soon as your still begins to work, fasten to the nose of the worm two ounces of English saffron, tied up in a cloth, that the liquor may run through it, and extract all its tincture; and, in order to this, you should often press the saffron with your fingers. When the operation is finished, dulcify your goods with fine sugar. —Or,

Ten Gallons of Usquebaugh by Digestion.

Take of raisins, stoned, five pounds; figs, sliced, one pound and an half; cinnamon, half a pound; nutmegs, three ounces; cloves and mace, of each one ounce and an half; liquorice, two pounds; saffron, four ounces; bruise the spices, slice the liquorice, and pull the saffron in pieces; digest these ingredients eight days in ten gallons of proof spirit, in a vessel close stopped; then filter the liquor, and add to it two gallons of Canary wine, and half an ounce of the tincture of ambergris.

Ten Gallons of Royal Usquebaugh by Distillation.

Take of cinnamon, ginger, and coriander seed, each three ounces; nutmegs, four ounces and an half; mace, cloves, and cubebs, of each one ounce and an half. Bruise these ingredients, and put them into an alembic, with lemon and orange peel, pared off thin, four ounces of each dried, or double the quantity of fresh peeled, and eleven gallons of proof spirit and two gallons of water, and distil till the feints begin to rise; fastening four ounces and an half of English saffron, tied in a cloth, to the end of the worm, that the liquor may run through it.

Take raisins, stoned, four pounds and a half; dates, three pounds; liquorice root, sliced, two pounds; digest these twelve hours in two gallons of water; strain out the clear liquor, add it to that obtained by distillation, and dulcify the whole with fine sugar.

Recipe for Two Gallons of Eau de Luce.

Take of the oil of amber, one ounce; of highly rectified spirit of wine, four pounds; put them into a bottle, and let them remain there five days, shaking the bottle from time to time, by which means the spirit will be strongly impregnated with the oil; then put into this impregnated spirit four ounces of the choicest amber, finely powdered, and let it digest three days, by which means you have a very rich tincture of amber.

The tincture of amber being thus made, take of the strongest spirit of sal ammoniac sixteen pounds, and add it to the foregoing tincture, together with eight pounds of highly rectified spirit of wine.

Thus you will obtain the celebrated water called Eau de Luce, so greatly in request, and so useful in all faintings and lowness of spirits.

Wormwood Cordial by Distillation.

There are two sorts of wormwood cordial, distinguished by the epithets of greater and lesser.

Recipe for making Ten Gallons of the Lesser Composition of Wormwood Cordial.

Take of the leaves of dried wormwood, five pounds; of the lesser cardamom seeds, five ounces; of coriander seeds, one pound; of clean proof spirit, eleven gallons; water, one gallon; draw off ten gallons, or till the feints begin to rise, with a gentle fire. It may be dulcified with sugar or not, at pleasure.

Recipe for Ten Gallons of the Greater Composition of Wormwood Cordial.

Take of common and sea wormwood, dried, of each ten pounds; of sage, mint, and balm, dried, of each twenty handfuls; of the roots of galangal, ginger, calamus-aromaticus, and coriander, of each three ounces; of cinnamon, cloves, and nutmegs, the lesser cardamoms and cubebs, of each two ounces. Cut and bruise the ingredients as they require; digest them twenty-four hours in eleven gallons of fine proof spirit, and two gallons of water, and draw off ten gallons, or till the feints begin to rise, with a pretty brisk fire.

Cherry Brandy.

This liquor is greatly called for in town and country, and is made different ways. Some press out the juice of the cherries, and having dulcified it with sugar, add as much spirit to it as the goods will bear, or the price it is intended to be sold for. But the common method is to put the cherries, clean picked, into a cask, with a proper quantity of proof spirit; and after standing about eighteen days, the goods are drawn off into another cask for sale, and about two-thirds of the first quantity of spirits poured into the cask upon the cherries. This is to stand about a month to extract the whole virtue from the cherries, after which it is drawn off as before, and the cherries pressed, to take out the spirit they had absorbed. The proportion of cherries and spirit is not very nicely observed; the general rule is, to let the cask be about half filled with cherries, and then filled up with proof spirits. Some add to every twenty gallons of spirit half an ounce of cinnamon, an ounce of cloves, and about three pounds of sugar, by which the flavour of the goods is considerably increased. But in order to save expences, not only the spices and sugar are generally omitted, but also a great part of the cherries, and the deficiency supplied by the juice of elderberries. Your own reason, therefore, and the price you can sell the goods for, must direct you in the choice of your ingredients. By the same method you may make raspberry brandy; and if the colour of the goods be not deep enough, it may be improved by an addition of cherry brandy, elder juice, or other colouring substance, as logwood, &c.

Raspberry Brandy

Is infused much after the same manner with cherry brandy, and drawn off, and made fit for sale with about the same addition of brandy to what you draw off from the first, second, and third infusion, and dulcified accordingly, first making it of a bright deep colour; but omitting cinnamon and cloves in the first, but not in the second and third infusion.

The first infusion will be of a colour deep enough, without help or art to it; the second infusion will be somewhat paler, and must be made deeper coloured, by adding cherry brandy, about a quart to ten or more gallons of the said raspberry brandy; and the third infusion will take more cherry brandy to colour the raspberry, which your own judgment will direct you in; here you may assist the colour and flavour with the juice of the elder-berry.

To make Elder Juice.

When you make elder juice, let your berries be fully ripe, and all the stalks (which are very many) be clean picked from them; then, if you have a press for drawing all the juice from them, have ready four hair cloths, somewhat broader than your press, and lay one layer above another, having a hair cloth betwixt every layer, which must be laid very thin, and pressed first a little, and then more, till your press be drawn as close as you can; then take out the berries, and press all you have in the like manner; then take your pressed berries, and break out all the lumps, and put them into an open-headed vessel, and put upon them as much liquor as will just cover them, and let them infuse so for seven or eight days; then press it out, and either add to it the rest, or keep it separately for present use, and put your best juice into a cask proper for it to be kept in, and put one gallon of malt spirits, not rectified, to every twenty gallons of elder juice, which will effectually preserve it from becoming sour for two years at least.

Spirituous Tinctures, or Infusions.

Rectified spirit of wine is the direct menstruum of the resins and essential oils of vegetables, and totally extracts these active principles from sundry vegetable matters, which yield them to water either not at all, or only in part.

It dissolves likewise the sweet saccharine matter of vegetable, and generally those parts of animal bodies, in which their peculiar smells and tastes reside.

The virtues of many vegetables are extracted almost equally by water and rectified spirit; but in the watery and spirituous tinctures of them there is this difference, that the active parts, in the watery extractions, are blended with a large proportion of inert gummy matter, on which their solubility in this menstruum in a great measure depends, while rectified spirit extracts them almost pure from gum. Hence, when the spirituous tinctures are mixed with watery liquors, a part of what the spirit had taken up from the subject generally separates and subsides, on account of its having been freed from that matter, which, being blended with it in the original vegetable, made it soluble in water. This, however, is not universal; for the active parts of some vegetables, when extracted by rectified spirit, are not precipitated by water, being almost equally dissoluble in both menstrua.

Rectified spirit may be tinged by vegetables of all colours, except blue. The leaves of plants in general, which give out but little of their natural colour to watery liquors, communicate to the spirit the whole of their green tincture, which, for the most part, proves elegant, though not very durable.

General Rules for Extracting Tinctures.

1. The vegetable substances ought to be moderately and newly dried, unless they are expressly ordered otherwise. They should likewise be cut and bruised before the menstruum is poured on them.

2. If the digestion be performed in balneo, the whole success depends upon a proper management of the fire; it ought to be all along gentle, unless the hard texture of the subject should require it to be augmented; in which case, the heat may be increased so as to make the menstruum boil a little towards the end of the process.

3. Very large circulatory vessels ought to be employed for this purpose, which should be heated before they are luted to-

gether. Circulatory vessels are those which are so contrived, and of such a height, that the vapour which arises during the digestion, may be cooled and condensed in the upper part, and fall down again into the liquor below; by these means, the dissipation both of the spirit and of the volatile parts of the ingredients is prevented. They are generally composed of two long-necked matrasses, or bolt-heads; the mouth of one of which is to be inserted into that of the other, and the juncture secured by a piece of wet bladder.

The use of heating the vessels is to expel a part of the air, which otherwise, rarefying in the process, would endanger bursting them, or blowing off the uppermost matrass. A single matrass with a long neck, or with a glass pipe inserted into its mouth, is more commodious than the double vessel.

4. The vessel is to be frequently shaken during the digestion.

5. All tinctures should be suffered to settle before they are committed either to the filter or strainer.

6. In the tinctures (and distilled spirits likewise) designed for internal use, no other spirit, drawn from malt, molasses, or other fermented matter, is to be used, than that expressly prescribed.

7. Resins and resinous gums yield tinctures more successfully, if, after being ground into powder, they be mixed with some white sand, well washed and dried, which will prevent their running into lumps by the heat. If the powders prescribed be sufficient for this purpose, such an addition is unnecessary.

Bitter Tincture.

Take of gentian root, two ounces; yellow rind of Seville orange peel, dried, one ounce; lesser cardamom seeds, freed from the husks, half an ounce; proof spirit, two pints; digest without heat, and strain off the tincture.

This is a very elegant spirituous bitter. As the preparation is designed for keeping, lemon peel is an excellent ingredient in the watery bitter infusions.

Stomachic Elixir.

Take of gentian root, two ounces; Curaçoa oranges, one ounce; Virginian snake root, half an ounce; cochineal, half a drachm; French brandy, two pints.

Let them steep for three days, and then filter the elixir.

To make la Bonne Liqueur Vespetro, approved by the King's Physicians at Montpelier.

Take a bottle that holds more than two pints of Paris measure; put into it two pints of good brandy, and add the following seeds, well beaten together in a mortar, viz. two grains of angelica, one ounce of corianders, a pinch of fennel, and as much aniseed; add to these the juice of two citrons, with the dried peels, and one pound of sugar. Infuse the whole in a bottle four or five days, but be careful to shake it from time to time, for the purpose of melting the sugar, &c. Afterwards strain the liquor to purify it, then bottle it, and take care that it be well stopped.

This is good for pains in the stomach, vomiting, or indigestion, colics and indigestion, oppression on the chest, and shortness of breath. A spoonful taken in a morning just before going out, is a preservative against bad air, and also helps the gravel, strangury, &c.

CHAP. XIV.

THE FRENCH METHOD OF MAKING WINES, &c.

WINE, properly speaking, is the name of all liquors that have become spirituous by fermentation. Thus cyder, beer, hydromel or mead, and several other liquors, are wines. The principles and theory of the fermentation are also essentially the same; and all nutritive, vegetable, and animal matters containing sugar ready formed, are susceptible of the spirituous fermentation. Thus wine may be made of all the juices of plants, the sap of trees, the infusions and decoctions of farinaceous vegetables, the milk of frugiverous animals; and lastly, of all ripe succulent fruits. All these substances, however, are not equally proper to be changed into a good and generous wine.

Of all the substances susceptible of the spirituous fermentation, none is capable of being converted into so good wine as the juice of the grapes of France, or of other countries nearly in the same latitude or of the same temperature. The grapes of hotter countries, and even those of the south of France, do indeed furnish wines that have a more agreeable, that is, a sweeter taste; but these, though sufficiently strong, are not so spirituous as those of the provinces near the middle of France. From these latter wines the best brandy and vinegar are made. The juice of the grape, when newly expressed, and before it has begun to ferment, is called *must*, or in common language, *sweet wine*. It is turbid, has an agreeable taste, and is very laxative, and drank too freely, is apt to occasion *diarrhœas*. It is thicker than water, and becomes of a pitchy thickness when dried.

When the *must* is pressed from the grapes, and put into a proper vessel and place, with a temperature between fifty-five and sixty degrees, very sensible effects appear in a shorter or longer time. It swells and rarefies, so much so, as to overflow the vessel containing it, if nearly full. An intestine motion is excited amongst its parts, accompanied with a small hissing noise and evident ebullition. The bubbles rise to the surface, and at the same time a quantity of carbonic acid of such purity is engaged, so subtle and dangerous, that it is capable of instantly killing men and animals, unless the air is renewed. The skins, stones, and other grosser matters of the grapes, are buoyed up by the particles of disengaged air that adhere to their surface, are variously agitated, and are raised in the form of a scum, or soft and spongy crust that covers the whole liquor; but this, during the fermentation, is frequently raised and broken by the air disengaged from the liquor, which forces its way through it. Afterwards the crust subsides, and becomes entire as before. These effects continue as long as the fermentation is brisk, and at last gradually cease; then the crust being no longer supported, falls to the bottom of the liquor. At this time, if we would have a strong and generous wine, all sensible fermentation should be stopped, by putting the wine into close vessels, which should be carried into a cellar, or some cool place. After wine has remained a proper time in a state of repose, it differs essentially from the juice of the grapes before fermentation; it affects the head, and may occasion drunkenness, and has no longer the laxative quality of sweet wine. If it be distilled, it yields a volatile, spirituous, and inflammable liquor, called *spirit of wine*, or alcohol; this spirit is consequently a new being, produced by the fermentation called *vinous*, or spirituous. When the fermentation of wine is very slow and tedious it is never very good or spirituous; and therefore when the weather is too cold, the fermentation is generally assisted, by heating the place where it is made. A too hasty and violent fermentation may be hurtful, from the dissipation and loss of some of the spirits; but after the fermentation has apparently ceased, it ought to be continued in some degree, if we would have good wine; this stage of the business is called the *imperceptible fermentation.* During this time the quantity of alcohol gradually increases, and the separation of the acid salt, called *tartar*, takes place. This is a second sediment formed in the wine, and adheres to the sides of the vessels which contain it. As the taste of tartar is harsh and disagreeable, it is evident that the insensible fermentation has acquired more alcohol, and has disengaged itself of the greatest part of its tartar, and ought to be much better and more agreeable; and for this reason chiefly, *old* wine is universally preferable to *new* wine. But when sufficient time has not been allowed for the first fermentation, the unfermented matter that remains will then ferment in the bottles and close vessels in which it is put; hence these wines are always turbid, emit bubbles, and sometimes break the bottles, from the large quantity of air then disengaged. We have a striking instance of these effects in the wine of Champagne, which sometimes makes the corks fly out of the bottles. But this is frequently a contrivance to make the wine sparkle and froth when it is poured out into glasses, and that it may have a taste much more lively and *piquant* than other wines.

This sparkling quality, and all the effects depending upon it, are only caused by a considerable quantity of carbonic acid gas. But when this air is entirely disengaged from these wines, they no longer sparkle, lose their piquancy of taste, become mild, and sometimes insipid. The acid fermentation of wine is very slow when the wine is deposited in close vessels and in a cool place; but it gradually advances, so that in a certain time, instead of being improved, it at last becomes sour, and when this acidity can no longer be concealed by using certain substances, the best way is to sell the wine to the vinegar makers, as all honest wine merchants do.

Mode of making Vinegar at Paris and London.

The wine detained for this purpose, is mixed in a large tun with a quantity of wine lees, and the whole being transferred into cloth sacks, placed within a large iron-bound vat, the liquid matter is extruded through the sacks by super-incumbent pressure.

What passes through is put into large casks, set upright, having a small aperture at their tops. In these it is exposed to the heat of the sun in summer, or to that of a stove in winter. Fermentation comes on in a few days. If the heat should then rise too high, it is lowered by cool air, and the addition of fresh wine. The art of making good wine vinegar, consists in the skilful regulation of the fermentative temperature. In summer, the process is generally completed in a fortnight; in winter, double the time is requisite. The vinegar is then run off into barrels, containing several chips of birchwood. It is clarified in about a fortnight; and to be fit for the market, must be kept in close casks.

English Vinegar.

Vinegar in this country, Dr. Ure observes, is usually made from malt. By mashing with hot water, 100 gallons of wort are extracted in less than two hours from one boll of malt. When the liquor has fallen to the temperature of 75° Fahrenheit, four gallons of the barm of beer are added. After thirty-six hours it is racked off into casks, which are laid on their sides, and exposed, with their bung-holes loosely covered, to the sun in summer; but in winter they are arranged in a stove-room. In three months this vinegar is ready for the manufacture of the sugar of lead. To make vinegar for domestic use, however, the process is somewhat different. The above liquor is racked off into casks placed upright, having a false cover pierced with holes, fixed at about a foot from their bottom. On this a considerable quantity of *rape*, or the refuse from the makers of British wine, or, otherwise a quantity of low-priced raisins, is laid. The liquor is turned into another barrel every twenty-four hours, in which time it has begun to grow warm. Sometimes, indeed, the vinegar is fully fermented as above, without the *rape*, which is added towards the end, to communicate flavour.

Good vinegar may be made from a weak syrup of eighteen ounces of sugar to every gallon of water. Yeast and rye are to be used as above described. Vinegar obtained by the preceding methods, has more or less of a brown colour, and a peculiar, but rather grateful smell.

CHAP. XV.

GENERAL RULES FOR THE DISTILLATION OF SIMPLE WATERS.

Plants and their parts ought to be fresh gathered. Where they are directed fresh, such must only be employed; but some are allowed to be used dry, as in this state they may be easily procured at all times of the year, though rather more elegant waters might be obtained from them whilst quite green.

Having bruised the subjects a little, pour thereon thrice their quantity of spring water. The quantity, however, may be diminished or added to, according as the plants may be more or less juicy than ordinary. When fresh and juicy herbs are to be distilled, thrice their weight of water will be fully sufficient; but dry ones require a much greater quantity.

In general, there should be so much water, that after all intended to be distilled has come over, there may be liquor enough left to prevent the matter from burning to the still.

Formerly, some vegetables were slightly fermented with the addition of yeast, previous to the distillation.

If any drops of oil swim on the surface of the water, they are carefully taken off.

That the waters may be kept the better, about one-twentieth part of their weight of proof spirit may be added to each, after they are distilled.

Stills used for Simple Waters.

The instruments chiefly used in the distillation of simple waters, are of two kinds, commonly called the hot still, or alembic, and the cold still.

The waters drawn by the cold still from plants are much more fragrant, and more fully impregnated with their virtues than those drawn by the hot still, or alembic. The method is this:

A pewter body is suspended in the body of the alembic, and the head of the still fitted to the pewter body; into this body the ingredients to be distilled are put, the alembic filled with water, the still-head luted to the pewter body, and the nose luted to the worm of the refrigeratory or worm.

The same intention will be answered, by putting the ingredients into a glass alembic, and placing it in a bath heat, or *balneum mariæ.*

The cold still is much the best adapted to draw off the virtues of simples, which are valued for their fine flavour when green, which is subject to be lost in drying; for when we want to extract from plants a spirit so light and volatile as not to subsist in open air any longer than while the plant continues in its growth, it is certainly the best method to remove the plant from its native soil, into some proper instrument, where, as it dies, these volatile parts can be collected and preserved. And such an instrument is what we call the cold still, where the drying of the plant, or flower, is only forwarded by a moderate warmth, and all that rises is collected and preserved.

As the method of performing the operation by the cold still is the very same, whatever plant or flower is used, the following instance of procuring a water from rosemary, will be abundantly sufficient to instruct the young practitioner in the manner of conducting the process in all cases whatever.

Rosemary Water.

Take rosemary, fresh gathered, in its perfection, with the morning dew upon it, and lay it lightly and unbruised upon the plate or bottom of the still; cover the plate with its conical head, and apply a glass receiver to the nose of it. Make a small fire of charcoal under the plate, continuing it as long as any liquor comes over into the receiver.

When nothing more comes over, take off the still-head, and remove the plant, putting fresh in its stead, and proceed as before; continue to repeat the operation successively, till a sufficient quantity of water is procured.

Let this distilled water be kept at rest in clean bottles, close stopped, for some days in a cold place; by this means it will become limpid, and powerfully impregnated with the taste and smell of the plant.

In this water are contained the liquor of dew, consisting of its own proper parts, which are not without difficulty separated from the plant, and cleave to it even in drying. This dew also, by sticking to the outside, receives the liquid parts of the plant, which being elaborated the day before, and exhaled in the night, are hereby detained, so that they concrete together into one external liquid, which is often viscid, as appears in manna, honey, &c.

SIMPLE DISTILLED WATERS.

Simple Alexeterial Water.

TAKE of spearmint leaves, fresh, a pound and an half; sea-wormwood tops, fresh, angelica leaves, fresh, each one pound; water, as much as is sufficient to prevent burning. Draw off by distillation three gallons.—Or,

Take of elder flowers, moderately dried, two pounds; angelica leaves, fresh gathered, one pound; water, a sufficient quantity. Distil off three gallons.

These waters are sufficiently elegant with regard to taste and smell, though few expect from them such virtues as their title seems to imply.

Simple Cinnamon Water.

Take of cinnamon, one pound; water, a gallon and an half; steep them together for two days, and then distil off the water till it ceases to run milky.

This is a very grateful and useful water, possessing in an eminent degree the fragrance and aromatic virtues of the spice.

Simple Peppermint Water.

Take of peppermint leaves, dry, a pound and an half; water, as much as will prevent the leaves burning.

Draw off by distillation one gallon.

This is a very elegant and useful water. It has a warm pungent taste, exactly resembling that of the peppermint itself.

Simple Pennyroyal Water.

Take of pennyroyal leaves, dry, a pound and an half; water, as much as will prevent burning.

Draw off by distillation one gallon.

Water of Pennyroyal.

Take of pennyroyal leaves, fresh, any quantity; water, three times as much. Distil as long as the water comes off well flavoured of the herb.

These waters possess, in a considerable degree, the smell, taste, and virtues of pennyroyal. They are frequently taken in hysteric cases, and not without good effects.

Damask Rose-Water.

Take of damask roses, fresh gathered, six pounds; water, as much as will keep them from burning. Distil off a gallon of the water.—Or,

Take three parts of water to one of the fresh roses, and distil as long as the water which comes over has smell of the flowers.

This water is principally valued on account of its fine flavour, which approaches to that generally in the rose itself. The purgative virtue of the roses remains entire in the liquor left in the still, which has therefore been generally employed for making the solutive honey and syrup, instead of decoction or infusion of fresh roses prepared on purpose; and this piece of frugality the College have now admitted.

Orange-Flower Water.

Take two pounds of orange-flowers, and twenty-four quarts of water, and draw over three pints.—Or,

Take twelve pounds of orange-flowers, and sixteen quarts of water, and draw over fifteen quarts.

One Gallon of Orange-Peel Water.

Take of the outward yellow rind of Seville oranges, four ounces; water, three gallons and an half; draw off one gallon by the alembic, with a pretty brisk fire.

Orange Wine.

Take twelve oranges, and pare them very thin; strain the juice so that none of the seeds go in with it; then take six pounds of loaf sugar, and the whites of two eggs well beaten; put these into three gallons of spring water, and let it gently boil for half an hour; as the scum rises, take it off, then add the orange juice and rind. You must put also three or four spoonsful of yeast, and let it stand in a pan or pail four or five days; then put it in your cask, and let it stand for three or four weeks, but do not stop it close for the first week. When nearly fine, draw it off into another cask, and add to it a quart of white wine, and a little Cognac brandy. Stop it close, and in a month or six weeks it will be fit for use.

Simple Spearmint Water.

Take of spearmint leaves, fresh, any quantity; water, three times as much. Distil as long as the liquor which comes over has a considerable taste or smell of the mint.—Or, Take spearmint leaves, dried, a pound and a half; water, as much as is sufficient to prevent burning. Draw off by distillation, one gallon.

These waters smell and taste very strong of the mint; and prove, in many cases, useful stomachics.

Capillaire.

Take ten pounds of loaf, and sixteen pounds of Lisbon sugar, with six eggs; let them be well beat together, and then boil them in three gallons of water, skimming it as long as any scum appears; then strain it through a bag, and add two pennyweights of essence of lemon.

CHAP. XVI.

OF MAKING COMPOUNDS OR CORDIALS.

THE perfection of this grand branch of distillery, depends upon the observation of the following general rules, easy to be observed and practised.

The artist must always be careful to use a well cleansed spirit, or one freed from its own essential oil. For as a compound cordial is nothing more than a spirit impregnated with the essential oil of the ingredients, it becomes necessary that this spirit should have deposited its own.

Let the time of previous digestion be proportioned to the tenacity of the ingredients, or the ponderosity of their oil. Thus cloves and cinnamon require a longer digestion before they are distilled, than calamus aromaticus, or orange-peel. Sometimes cohobation (as subsequently explained) is necessary; for instance, in making the strong cinnamon cordial, because the essential oil of cinnamon is so extremely ponderous, that it is difficult to bring over the helm with the spirit without cohobation.

Let the strength of the fire be proportioned to the ponderosity of the oil intended to be raised with the spirit. Thus, for instance, the strong cinnamon cordial requires a much greater degree of fire than that from lax vegetables, as mint, balm, &c.

Let a due proportion of the finest parts of the essential oil be united with the spirit; the grosser and less fragrant parts of the oil not giving the spirit so agreeable a flavour, and at the same time renders it thick and unsightly. This may in a great measure be effected by leaving out the feints, and making up to proof with fine soft water in their stead.

These four rules, carefully observed, will render this extensive part of distillation far more perfect than it is at present. Nor will there be any occasion for the use of burnt alum, white of eggs, isinglass, &c. to fine down cordials, for they will presently be fine, sweet, and pleasant tasted, without any further trouble.

Recipe for Sixteen Gallons of strong Cinnamon Cordial.

Cinnamon is a very useful and elegant aromatic bark, of a fragrant delightful smell, and sweet pungent taste, with some degree of astringency; it corroborates the viscera, and proves of great service in all kind of alvine fluxes, and immoderate discharges from the uterus; it is cordial and stomachic.

Take eight pounds of fine cinnamon, bruised; seventeen gallons of clear rectified spirit, and two gallons of water. Put them into your still, and digest them twenty-four hours with a gentle heat; after which, draw off sixteen gallons by a pretty strong heat.

I have ordered a much larger quantity of cinnamon than is common among distillers; because when made in the manner above directed, it is justly looked upon as one of the noblest cordials of the shops; but when made in the common way, of two pounds to twenty gallons of spirit, as some have ordered, is only an imposition on the buyer.

Recipe for Ten Gallons of Hungary Water.

Rosemary, the principal ingredient in Hungary water, has always been a favourite shrub in medicine; it is full of volatile parts, as appears by its taste and smell. It is a very valuable cephalic, and is good in all disorders of the nerves; in hysteric and hypochondriac cases, in palsies, apoplexies, and vertigoes. Some suppose that the flowers possess the virtues of the whole plant in a more exalted degree than any other part; but the flowery tops, leaves, and husks, together with the flowers themselves, are much fitter for all purposes, than the flowers alone.

Take of the flowery tops, with the leaves and flowers of rosemary, fourteen pounds; rectified spirit, eleven gallons and a half; water one gallon; distil off ten gallons with a moderate fire. If you perform this operation in *balneum mariæ*, your Hungary water will be much finer than if drawn by the common alembic.

This is called Hungary water, from its

being first made for a princess of that kingdom.

Some add lavender flowers, and others Florentine orange root; but what is most esteemed is made with rosemary only.

Recipe for Ten Gallons of Simple Lavender Water.

Take fourteen pounds of lavender flowers, ten gallons and a half of rectified spirit of wine, and one gallon of water; draw off ten gallons with a gentle fire, or, which is much better, in *balneum mariæ.*

Both the Hungary and lavender water may be made at any time of the year, without distillation.

Recipe for making Three Gallons of Compound Lavender Water.

Take of lavender water, above described, two gallons; of Hungary water, one gallon; cinnamon and nutmegs, of each three ounces; and of red saunders, one ounce; digest the whole three days in a gentle heat, and then filter it for use. Some add saffron, musk, and ambergris, of each half a scruple; but those are now generally omitted.

Recipe for Ten Gallons of Cardamom Cordial.

The seed from whence this cordial takes its name, is called by botanists cardamum minus, or the lesser cardamom; to distinguish it from the cardamomum majus, or grains of paradise.

The lesser cardamom is a small short fruit, or membraneous capsule, of a triagonal form, about a third of an inch long, and swelling out thick about the middle, beginning small and narrow from the stalk, and terminating in a small but obtuse point at the end. It is striated all over very deeply with longitudinal furrows, and consists of a thin but very tough membrane, of a fibrous texture, and pale brown colour, with a faint cast of red.

When the fruit is thoroughly ripe, this membrane opens at the three edges all the way, and shows that it is internally divided by three thin membranes into three cells, in each of which is an arrangement of seeds, separately lodged in two series. The seeds are of an irregular angular figure, rough, and of a dusky brown colour on the surface, with a mixture of yellowish and reddish, and of a white colour within. They have not much smell, unless first bruised, when they are much like camphor under the nose. They are of an acrid, aromatic, and fiery hot taste. They should be chosen sound, close shut on all sides, and full of seeds of a good smell and of an acrid aromatic taste.

Take of the lesser cardamom seeds, husked, two pounds and an half; of clean proof spirit, ten gallons and an half; and of water, one gallon; draw off ten gallons by a gentle heat. You may either dulcify it or not with fine sugar, at pleasure.

This water is carminative, assists digestion, and is good to strengthen the head and stomach. A tincture or infusion is still better.

Recipe for a Gallon of Jamaica Pepper Water.

Jamaica pepper is the fruit of a tall tree growing in the mountainous parts of Jamaica, where it is much cultivated, because of the great profit arising from the cured fruit, sent in large quantities annually into Europe.

Take of Jamaica pepper, half a pound; water, two gallons and an half; draw off one gallon with a pretty brisk fire. The oil of this fruit is very ponderous, and therefore this water is best made in an alembic.

Recipe for Five Quarts of Compound Gentian Water.

Gentian root, sliced, three pounds; leaves and flowers of the lesser centaury, of each eight ounces; infuse the whole in six quarts of proof spirits, and one quart of water; and draw off the water till the feints begin to rise. This water is frequently used as being a very fine stomachic.

DISTILLED SPIRITUOUS WATERS.

By distilled spirits are understood such as are drawn with a spirit that has been previously rectified, or which is reduced nearly to that strength in the operation; by spirituous waters, those in which the spirit is only of the proof strength, or contains an admixture of about an equal measure of water. These last have been usually called compound waters, even when distilled from one ingredient only; as those, on the other hand, which are drawn by common water, though from a number of ingredients, are named simple; the title simplex, here relating not to simplicity in respect of composition, but to the vehicles being plain water.

General Rules for the Distillation of Spirituous Waters.

The plants and their parts ought to be moderately and newly dried, except such as are ordered to be fresh gathered.

After the ingredients have been steeped

in the spirit for the time prescribed, add as much as will be sufficient to prevent a burnt flavour, or rather more.

The liquor which comes over first in the distillation, is by some kept by itself, under the title of spirit; and the other runnings, which prove milky, fined down by art. But it is better to mix all the runnings together, without fining them, that the waters may possess the virtues of the plant entire; which is a circumstance to be more regarded than their fineness or sightliness.

In the distillation of these waters, the genuine brandy obtained from wine is directed.

Where this is not to be had, take instead of that proof spirit, half its quantity, of a well-rectified spirit, prepared from any other fermented liquors. In this steep the ingredients, and then add spring water enough, both to make up the quantity ordered to be drawn off, and to prevent burning.

By this method, more elegant waters may be obtained than when any of the common proof spirits, even that of wine itself, are made use of. All vinous spirits receive some flavour from the matter from which they are extracted; and of this flavour, which adheres chiefly to the phlegm or watery part, they cannot be divested without separating the phlegm, and reducing them to the rectified state of spirits of wine.

Recipe for Ten Gallons of Lemon-Water.

The peel of the lemon, the part used in making this water, is a very grateful bitter aromatic, and on that account very serviceable in repairing and strengthening the stomach.

Take dried lemon-peel four pounds, clean proof spirit ten gallons and a half, and one gallon of water. Draw off ten gallons by a gentle fire. Some dulcify lemon-water, but by that means its virtues, as a stomachic, are greatly impaired.

Recipe for One Gallon of Jessamine Water.

There are several species of jessamine, but that sort intended here, is what gardeners call Spanish White, or Catalonian Jessamine.

This is one of the most beautiful of all the species of jessamine.

Take of Spanish jessamine flowers, twelve ounces; essence of Florentine citron, or bergamot, eight drops; fine proof spirit, one gallon; water, two quarts. Digest two days in a close vessel, after which draw off one gallon, and dulcify with fine loaf sugar.

Recipe for One Gallon of Spirit of Scurvy-grass.

Scurvygrass, fresh gathered and bruised, fifteen pounds; horseradish root, six pounds; rectified spirit of wine, one gallon; and three pints of water; digest the whole in a close vessel two days, and draw off a gallon with a gentle fire.

This is of great service in all scorbutic cases, and is given from twenty to eighty drops.

Antiscorbutic Water.

Take of the leaves of water-cresses, garden and sea scurvygrass, and brook-lime, of each twenty handfuls; of pine tops, germander, horehound, and the lesser centaury, of each sixteen handfuls; of the roots of briony and sharp-pointed dock, of each six pounds; of mustard-seed, one pound and an half. Digest the whole in ten gallons of proof spirit, and two gallons of water, and draw off by a gentle fire.

This is a fine water for the cure of scorbutic disorders. As also in tremblings, and disorders of the nerves.

Recipe for Ten Gallons of Plague Water.

There are several methods for making plague water; the following I presume is the best:—

Take of the roots of masterwort and butterburr, of each one pound and a quarter; of Virginia snake-root and zedoary, of each ten ounces; angelica seeds and bay-seeds, of each fourteen ounces; and of leaves of scordium, one pound and a half. Cut or bruise these ingredients, and put them into the still, with twelve gallons of clean proof spirit, and two gallons of water; digest the whole for twenty-four hours, and draw off ten gallons.

Recipe for making Ten Gallons of Red Surfeit Water.

Take of the flowers of red poppies, two bushels, and eleven gallons of clean proof spirit, and digest them with a gentle heat for three days, or till the spirit has extracted all the colour of the flowers; then press out the liquor from the flowers, and add to the tincture of the seeds caraway and coriander, and liquorice-root, sliced, of each ten ounces; of cardamoms and cubebs, of each four ounces; of raisins, stoned, five pounds; of cinnamon, five ounces; of nutmegs, mace, and ginger, of each three ounces; of cloves, two drachms; of juniper berries, three ounces; let the whole be digested three days, then press out the liquor, adding to it a gallon of rose water, and then strain or filter the whole through a flannel bag.

Recipe for One Gallon of the Water Four Spices.

Four spices, viz. cloves, mace, nutmegs, and cinnamon.

Take of cinnamon, two ounces; nutmegs and cloves, of each three drachms; mace, six drachms; bruise the spices in a mortar, and add proof spirit one gallon, and water two quarts. Digest twenty-four hours in a close vessel, and distil with a brisk fire till the feints begin to rise, and dulcify with fine sugar.

This is an excellent stomachic, good in depression of spirits, and paralytic disorders.

Recipe for Three Gallons of Water for those afflicted with the Stone and Gravel.

Take of the best flowers of the white thorn, eight pounds; of nutmegs, bruised, six ounces; infuse them together six days in a close vessel with two gallons of generous white wine, and the same quantity of proof spirits; after which, draw the water, by a gentle distillation, till the feints begin to rise.

This water is of infinite use in fits of the stone and gravel, a glass of it often procuring ease in the racking pains of that dreadful disorder.

Recipe for Ten Gallons of Gout Water.

Take of the flowers of camomile, leaves of pennyroyal, lavender, marjoram, rosemary, sage, and ground-pine, of each eight ounces; myrrh, four ounces; cloves and cinnamon, of each one ounce; roots of piony, two ounces; pellitory of Spain, and Cypress orrice, of each one ounce; the lesser cardamoms and cubebs, of each half an ounce; nutmegs, two ounces; cut and bruise these ingredients, and digest them four days in eleven gallons of proof spirit, and two gallons of water, then draw off ten gallons, and dulcify with fine sugar.

This is reckoned a fine cordial for the above complaint, and also good in all nervous cases; and a continued moderate use of it will comfort and fortify the fibres, so as to prevent the discharge of such juices upon the joints as cause arthritic pains and swellings. It is also of excellent use in palsies, epilepsies, and loss of memory, particularly when these distempers proceed from old age, or when the principal springs of life begin to decay.

Recipe for making a Gallon of Beauty Water, or Eau de Beauté.

This water has its name from its use in washing the face, and giving an agreeable smell. It is drawn from thyme and marjoram, which gives it a very elegant odour.

Take of the flowery tops of thyme and marjoram, of each one pound; proof spirits, five quarts; water, one quart. Draw off in *balneum mariæ*, till the feints begin to rise, and keep it close stopped for use.

Essence of Ambergris.

Ambergris, in its natural or common form, is a lax and coarse substance of an irregular structure, friable, and so light as to swim upon water; it is of a pale grey colour, with a faint tinge of brown in it; but pieces perfectly and uniformly of this colour are rare; what we usually meet with is composed of whitish, yellowish, and blackish granules; and in proportion as there is more or less of this whitish matter in these masses, it is more or less scented and valuable. It is found in pieces perfectly irregular, and from the bigness of a pea to those of ten, twenty, or more pounds; nay, there have been masses found of more than two hundred weight.

It should be chosen in clean, and not over friable pieces, of a pale grey colour, and as uniform as possible in its structure, with small black specks within.

There are two sorts of essences made from this perfume; one, without addition of any other odoriferous substance, and the other from ambergris, compounded with musk and civet.

Recipe for making the Essence of Ambergris.

Take of ambergris and white sugar-candy, of each three drachms; grind them well together in a glass mortar, adding to them, by slow degrees, five ounces of rectified spirit of wine; digest the whole in a matrass, well stopped, for four days, and then separate the clear tincture or essence, in a bottle, well stopped, for use.

Recipe for making the Compound Essence of Ambergris.

Take of ambergris and white sugar-candy, of each two drachms; musk, twelve grains; grind all these well together in a glass mortar, adding by degrees four ounces of rectified spirit of wine; digest, and separate the clear essence for use, as in the preceding recipe.

2. Musk is a dry, light, and friable substance, of a dark blackish colour, with some tinge of a purplish or blood colour in it. It is soft, and somewhat smooth and unctuous to the touch, and of a highly perfumed smell. It is brought to us sewed up in a kind of bladders or cases of skin, covered with brownish hair, which are the real bags in which the musk is lodged, while on the animal.

Musk should be chosen of a very strong scent, and in dry sound bladders; and must be kept close shut down in a leaden box, by which means it will retain its smell, and not grow too dry.

Recipe for making the Essence of Musk.

Take of musk and white sugar-candy, of each one drachm; rub them well together in a marble mortar, adding by degrees, during the rubbing, five ounces of rectified spirit of wine; put the whole into a matrass; digest three days in a gentle heat, and pour off the clear essence, which keep in a bottle well stopped for use. Some add a few grains of civet to their essence of musk, which considerably augments the fineness of the perfume.

3. Civet is produced like musk, in bags growing to the lower part of the belly of an animal. It is of different colours, from a pure lively whitish to a black; but the nearer it approaches to the white the better it is; of an extremely strong smell, and a bitterish pungent taste.

The essence of civet is rarely used alone, but of great service in making additions to other odoriferous waters, and therefore I shall here give the method of making it.

Recipe for making the Essence of Civet.

Take of civet and double refined sugar, of each two drachms; rub them well together in a glass mortar, adding, by degrees, five ounces of rectified spirit of wine; put the whole into a matrass; digest three days in a gentle heat, and pour off the clear essence for use.

Though the essences are, properly speaking, chemical preparations, and therefore might be foreign to the business of a distiller, yet as they are often added to perfumed waters, and easily made, I thought the foregoing recipes would not be unacceptable to the reader.

Recipe for Two Gallons of Aromatic Cephalic Water.

This water has its name from its delicate smell, and great use in all swimmings and giddiness in the head.

Nutmegs, mace, cloves, and cinnamon, of each two ounces; galangals, and calamus aromaticus, of each one drachm; flowers of lavender, three handfuls; infuse the whole in nine quarts of proof spirit, and draw off two gallons by gentle distillation.

This is an excellent composition; it makes an admirable cordial, and may be rendered more pleasant by sweetening it with sugar.

Balm Water, commonly called Eau de Carmes.

Take of balm in flower, fresh gathered and clear from the stalks, two pounds; lemon-peel, fresh, as soon as pared from the fruit, four ounces; coriander seeds, eight ounces; nutmegs, cloves, cinnamon, each, bruised, two ounces; angelica roots, dried and bruised, one ounce; spirit of wine, highly rectified, ten pints. Steep the several ingredients in the spirit four or five days, and then draw off, in the heat of a water bath, ten pints. Rectify the distilled liquor by a second distillation in a water-bath, drawing off only about eight pints and three quarters.

Balsamum Vitæ.

Take of cinnamon, one ounce and an half; ginger, one ounce; mint, one ounce; oil of vitriol, six ounces; rectified spirit of wine, two pounds.

Drop the oil of vitriol by little and little into the spirit of wine, and digest them together in a sand-bath, with a very gentle heat, for three days; then add the other ingredients; continue the digestion, in the same gentle heat, for three days longer, and afterwards filter the tincture in a glass funnel.

Sweet Elixir of Vitriol.

Take of the aromatic tincture, one pint; dulcified spirit of vitriol, eight ounces by weight. Mix them together.

This is designed for persons whose stomachs are too weak to bear the foregoing acid elixir.

A

COMPLETE SET OF TABLES,

EXHIBITING

THE EXACT WEIGHT

OF

SPIRITUOUS LIQUORS,

FROM THE LOWEST QUALITY TO ALCOHOL:

AND ALSO OF

WATER AND VINEGAR,

FROM ONE GALLON TO TWO HUNDRED AND FIFTY-TWO, OR ONE TUN.

N^o 5

Gallons.	*Weight of Water.*					*Weight of Spirits under Proof.*									
						1 in 2					1 in 4				
	C.	qr.	lb.	oz.	dr.	C.	qr.	lb.	oz.	dr.	C.	qr.	lb.	oz.	dr.
1	0	0	8	7	5	0	0	8	1	4	0	0	7	15	5
2	0	0	16	14	10	0	0	16	2	8	0	0	15	14	10
3	0	0	25	5	15	0	0	24	3	12	0	0	23	13	15
4	0	1	5	13	4	0	1	4	5	0	0	1	3	13	4
5	0	1	14	4	9	0	1	12	6	4	0	1	11	12	9
6	0	1	22	11	14	0	1	20	7	8	0	1	19	11	14
7	0	2	3	3	3	0	2	0	8	12	0	1	27	11	3
8	0	2	11	10	8	0	2	8	10	0	0	2	7	10	8
9	0	2	20	1	13	0	2	16	11	4	0	2	15	9	13
10	0	3	0	9	2	0	2	24	12	8	0	2	23	9	2
20	1	2	1	2	4	1	1	21	9	0	1	1	19	2	4
25	1	3	15			1	3	6			1	3	3		
30	2	1	2			2	0	18			2	0	14		
35	2	2	16			2	2	2			2	1	25		
40	3	0	2			2	3	15			2	3	9		
45	3	1	17			3	1	0			3	0	21		
50	3	3	3			3	2	12			3	2	3		
55	4	0	17			3	3	24			3	3	14		
60	4	2	3			4	1	9			4	0	26		
65	4	3	17			4	2	21			4	2	9		
70	5	1	4			5	0	6			4	3	20		
75	5	2	18			5	1	18			5	1	4		
80	6	0	4			5	3	2			5	2	15		
85	6	1	18			6	0	15			5	3	27		
90	6	3	5			6	1	27			6	1	10		
95	7	0	19			6	3	12			6	2	22		
100	7	2	5			7	0	24			7	0	5		
110	8	1	6			7	3	21			7	3	0		
120	9	0	6			8	2	18			3	1	23		
130	9	3	7			9	1	14			9	0	18		
140	10	2	7			10	0	11			9	3	13		
150	11	1	8			10	3	8			10	2	8		
160	12	0	8			11	2	5			11	1	3		
170	12	3	9			12	1	2			11	3	26		
180	13	2	10			12	3	26			12	2	21		
190	14	1	10			13	2	23			13	1	16		
200	15	0	11			14	1	20			14	0	11		
210	15	3	12			15	0	17			14	3	6		
220	16	2	12			15	3	13			15	2	1		
240	18	0	13			17	1	6			16	3	18		
252	19	0	2			18	0	19			17	3	1		

lb. oz. dr. C. qr. lb.
N. B. A gallon of spirits at 1 in 3, weighs 7 15 6, and a tun 17 8 17
Ditto .... at 1 in 5, weighs 7 13 12, and a tun 17 2 20

Weight of Spirituous Liquors under Proof.

Gallons.	1 in 6.					1 in 8.					1 in 10.				
	C.	qr.	lb.	oz.	dr.	C.	qr.	lb	oz.	dr.	C.	qr.	lb.	oz.	dr.
1	0	0	7	13	7	0	0	7	12	12	0	0	7	12	7
2	0	0	15	10	14	0	0	15	9	8	0	0	15	8	4
3	0	0	23	8	5	0	0	23	6	4	0	0	23	5	5
4	0	1	3	5	12	0	1	3	3	0	0	1	3	1	12
5	0	1	11	3	3	0	1	10	15	12	0	1	10	14	3
6	0	1	19	0	10	0	1	18	12	8	0	1	18	10	10
7	0	1	26	14	1	0	1	26	9	4	0	1	26	7	1
8	0	2	6	11	8	0	2	6	6	0	0	2	6	3	8
9	0	2	14	8	15	0	2	14	2	12	0	2	13	15	15
10	0	2	22	6	6	0	2	21	15	8	0	2	21	12	6
20	1	1	16	12	12	1	1	15	15	0	1	1	15	8	12
25	1	3	0			1	2	26			1	2	26		
30	2	0	11			2	0	9			2	0	9		
35	2	1	22			2	1	19			2	1	19		
40	2	3	5			2	3	3			2	3	2		
45	3	0	16			3	0	14			3	0	13		
50	3	2	0			3	1	26			3	1	25		
55	3	3	11			3	3	9			3	3	8		
60	4	0	22			4	0	20			4	0	19		
65	4	2	5			4	2	3			4	2	2		
70	4	2	16			4	3	14			4	3	13		
75	5	0	27			5	0	25			5	0	24		
80	5	2	10			5	2	8			5	2	6		
85	5	3	22			5	3	19			5	3	17		
90	6	1	5			6	1	2			6	1	0		
95	6	2	16			6	2	13			6	2	11		
100	6	3	27			6	3	24			6	3	22		
110	7	2	21			7	2	18			7	2	16		
120	8	1	16			8	1	12			8	1	10		
130	9	0	10			9	0	6			9	0	4		
140	9	3	4			9	3	0			9	2	25		
150	10	1	27			10	1	22			10	1	19		
160	11	0	21			11	0	16			11	0	13		
170	11	3	15			11	3	10			11	3	7		
180	12	2	10			12	2	4			12	2	1		
190	13	1	4			13	0	26			13	0	22		
200	13	3	26			13	3	20			13	3	16		
210	14	2	21			14	2	14			14	2	10		
220	15	1	15			15	1	8			15	1	4		
240	16	3	3			16	2	24			16	2	20		
252	17	2	13			17	2	6			17	2	1		

lb. oz. dr. C. qr. lb.
N. B. A gallon of spirits at 1 in 7, weighs 7 13 2, and a tun 17 2 9.
Ditto .... at 1 in 9, weighs 7 12 8, and a tun 17 2 3.

	Weight of Spirituous Liquors under Proof.										*Hydrometer Proof.*				
Gallons.	1 in 15.					1 in 20.									
	C.	qr.	lb.	oz.	dr.	C	qr.	lb.	oz.	dr.	C.	qr.	lb.	oz.	dr.
1	0	0	7	12	2	0	0	7	11	13	0	0	7	11	3
2	0	0	15	8	4	0	0	15	7	10	0	0	15	6	6
3	0	0	23	4	6	0	0	23	3	7	0	0	23	1	9
4	0	1	3	0	8	0	1	2	15	4	0	1	2	12	12
5	0	1	10	12	10	0	1	10	11	1	0	1	10	7	15
6	0	1	18	8	12	0	1	18	6	14	0	1	18	3	2
7	0	1	26	4	14	0	1	26	2	11	0	1	25	14	5
8	0	2	6	1	0	0	2	5	14	8	0	2	5	9	8
9	0	2	13	13	2	0	2	13	10	5	0	2	13	4	11
10	0	2	21	9	4	0	2	21	6	2	0	2	20	15	14
20	1	1	15	2	8	1	1	14	12	4	1	1	13	15	12
25	1	2	26			1	2	25			1	2	24		
30	2	0	9			2	0	8			2	0	7		
35	2	1	19			2	1	18			2	1	17		
40	2	3	2			2	3	1			2	3	0		
45	3	0	13			3	0	12			3	0	11		
50	3	1	24			3	1	23			3	1	21		
55	3	3	7			3	3	6			3	3	4		
60	4	0	17			4	0	17			4	0	14		
65	4	2	0			4	1	27			4	1	25		
70	4	3	11			4	3	10			4	3	7		
75	5	0	22			5	0	21			5	0	18		
80	5	2	4			5	2	3			5	2	1		
85	5	3	15			5	3	14			5	3	11		
90	6	0	26			6	0	25			6	0	22		
95	6	2	9			6	2	8			6	2	4		
100	6	3	20			6	3	18			6	3	15		
110	7	2	13			7	2	12			7	2	8		
120	8	1	7			8	1	6			8	1	1		
130	9	0	0			8	3	27			8	3	22		
140	9	2	22			9	2	20			9	2	15		
150	10	1	15			10	1	14			10	1	8		
160	11	0	9			11	0	7			11	0	1		
170	11	3	3			11	3	0			11	2	22		
180	12	1	24			12	1	22			12	1	15		
190	13	0	18			13	0	15			13	0	8		
200	13	3	11			13	3	9			13	3	1		
210	14	2	4			14	2	2			14	1	22		
220	15	0	26			15	0	24			15	0	15		
240	16	2	14			16	2	11			16	2	2		
252	17	1	23			17	1	20			17	1	10		

Weight of Spirituous Liquors over Proof.

Gallons.	1 to 20.					1 to 15.					1 to 10.				
	C.	qr.	lb.	oz.	dr.	C.	qr.	lb.	oz.	dr	C.	qr.	lb.	oz.	dr.
1	0	0	7	10	9	0	0	7	10	9	0	0	7	10	4
2	0	0	15	5	2	0	0	15	5	2	0	0	15	4	8
3	0	0	22	15	11	0	0	22	15	11	0	0	22	14	12
4	0	1	2	10	4	0	1	2	10	4	0	1	2	9	0
5	0	1	10	4	13	0	1	10	4	13	0	1	10	3	4
6	0	1	17	15	6	0	1	17	15	6	0	1	17	13	8
7	0	1	25	9	15	0	1	25	9	15	0	1	25	7	12
8	0	2	5	4	8	0	2	5	4	8	0	2	5	2	0
9	0	2	13	15	1	0	2	13	15	1	0	2	12	12	4
10	0	2	20	9	10	0	2	20	9	10	0	2	20	6	8
20	1	1	13	3	4	1	1	13	3	4	1	1	12	13	0
25	1	2	23			1	2	23			1	2	23		
30	2	0	6			2	0	6			2	0	5		
35	2	1	16			2	1	16			2	1	15		
40	2	2	26			2	2	26			2	2	25		
45	3	0	8			3	0	8			3	0	7		
50	3	1	19			3	1	19			3	1	18		
55	3	3	2			3	3	1			3	3	0		
60	4	0	12			4	0	11			4	0	10		
65	4	1	22			4	1	22			4	1	20		
70	4	3	5			4	3	4			4	3	2		
75	5	0	15			5	0	14			5	0	12		
80	5	1	26			5	1	25			5	1	23		
85	5	3	8			5	3	7			5	3	5		
90	5	0	18			6	0	17			6	0	15		
95	6	2	1			6	1	27			6	1	25		
100	6	3	11			6	3	10			6	3	7		
110	7	2	4			7	2	2			7	2	0		
120	8	0	24			8	0	23			8	0	20		
130	8	3	17			8	3	15			8	3	12		
140	9	2	10			9	2	8			9	2	4		
150	10	1	2			10	1	1			10	0	25		
160	10	3	23			10	3	21			10	3	17		
170	11	2	16			11	2	14			11	2	9		
180	12	1	8			12	1	6			12	1	2		
190	13	0	1			12	3	27			12	3	22		
200	13	2	22			13	2	19			13	2	14		
210	14	1	14			14	1	12			14	1	6		
220	15	0	7			15	0	5			14	3	27		
240	16	1	21			16	1	18			16	1	12		
252	17	1	1			17	0	26			17	0	19		

Weight of Spirituous Liquors over Proof.

Gallons.	1 to 8.					1 to 6.					1 to 4.				
	C.	qr.	lb.	oz.	dr	C.	qr.	lb.	oz.	dr.	C.	qr.	lb.	oz.	dr.
1	0	0	7	9	15	0	0	7	9	4	0	0	7	8	5
2	0	0	15	3	14	0	0	15	2	8	0	0	15	0	10
3	0	0	22	13	13	0	0	22	11	12	0	0	22	8	15
4	0	1	2	7	12	0	1	2	5	0	0	1	2	1	4
5	0	1	10	1	11	0	1	9	14	4	0	1	9	9	9
6	0	1	17	11	10	0	1	17	7	8	0	1	17	1	14
7	0	1	25	5	9	0	1	25	0	12	0	1	24	10	3
8	0	2	4	15	8	0	2	4	10	0	0	2	4	2	8
9	0	2	12	9	7	0	2	12	3	4	0	2	11	10	13
10	0	2	20	3	6	0	2	19	12	8	0	2	19	3	2
20	1	1	12	6	22	1	1	11	9	0	1	1	10	6	4
25	1	2	22			1	2	21			1	2	20		
30	2	0	4			2	0	3			2	0	1		
35	2	1	14			2	1	13			2	1	11		
40	2	2	24			2	2	23			2	2	21		
45	3	0	7			3	0	5			3	0	2		
50	3	1	17			3	1	15			3	1	12		
55	3	2	17			3	2	25			3	2	22		
60	4	0	9			4	0	7			4	0	3		
65	4	1	19			4	1	17			4	1	13		
70	4	3	1			4	2	27			4	2	22		
75	5	0	11			5	0	9			5	0	4		
80	5	1	21			5	1	19			5	1	14		
85	5	3	3			5	3	0			5	2	23		
90	6	0	13			6	0	10			6	0	5		
95	6	1	23			6	1	20			6	1	14		
100	6	3	5			6	3	2			6	2	24		
110	7	1	25			7	1	22			7	1	15		
120	8	0	18			8	0	14			8	0	6		
130	8	3	10			8	3	6			8	2	26		
140	9	2	2			9	1	26			9	1	17		
150	10	0	22			10	0	17			10	0	8		
160	10	3	14			10	3	9			10	2	27		
170	11	2	6			11	2	1			11	1	18		
180	12	0	26			12	0	21			12	0	10		
190	12	3	19			12	3	13			12	3	1		
200	13	2	11			13	2	4			13	1	20		
210	14	1	3			13	0	24			14	0	11		
220	14	3	23			14	3	16			14	3	2		
240	16	1	7			16	1	0			16	0	13		
252	17	0	15			17	0	7			16	3	19		

lb. oz. dr. C. qr. lb.
N. B. A gallon of spirits at 1 to 9, weighs 7 9 15, and a tun 17 0 17
Ditto .... at 1 to 7, weighs 7 9 10, and a tun 17 0 11.

	Weight of Spirits, P. O.					*Weight of Alcohol.*					*Weight of Vinegar.*				
Gallons.	1 to 2.										(Wine Measure).				
	C.	qr.	lb.	oz	dr.	C.	qr.	lb.	oz.	dr.	C.	qr.	lb.	oz.	dr.
1	0	0	7	5	7	0	0	6	15	6	0	0	8	7	0
2	0	0	14	10	14	0	0	13	14	12	0	0	16	14	0
3	0	0	22	0	5	0	0	20	14	2	0	0	25	5	0
4	0	1	1	5	12	0	0	27	13	8	0	1	5	12	0
5	0	1	8	11	3	0	1	6	12	14	0	1	14	3	0
6	0	1	16	0	10	0	1	13	12	4	0	1	22	10	0
7	0	1	23	6	1	0	1	20	11	10	0	2	3	1	0
8	0	2	2	11	8	0	1	27	11	0	0	2	11	8	0
9	0	2	10	0	15	0	2	6	10	6	0	2	19	15	0
10	0	2	17	6	6	0	2	13	9	12	0	3	0	6	0
20	1	1	6	12	12	1	0	27	3	8	1	2	0	12	0
25	1	2	15			1	2	6			1	3	15		
30	1	3	24			1	3	13			2	1	1		
35	2	1	5			2	0	19			2	2	15		
40	2	2	13			2	1	26			3	0	1		
45	2	3	22			2	3	5			3	1	16		
50	3	1	3			3	0	12			3	3	2		
55	3	2	11			3	1	19			4	0	16		
60	3	3	20			3	2	26			4	2	2		
65	4	1	1			4	0	4			4	3	16		
70	4	2	9			4	1	11			5	1	3		
75	4	3	18			4	2	18			5	2	17		
80	5	0	27			4	3	25			6	0	3		
85	5	2	7			5	1	4			6	1	17		
90	5	3	10			5	2	10			6	3	3		
95	6	0	25			5	3	17			7	0	18		
100	6	2	5			6	0	24			7	2	4		
110	7	0	23			6	3	10			8	1	4		
120	7	3	12			7	1	23			9	0	4		
130	8	2	1			8	0	9			9	3	5		
140	9	0	19			8	2	22			10	2	5		
150	9	3	8			9	1	8			11	1	6		
160	10	1	25			9	3	22			12	0	6		
170	11	0	15			10	2	7			12	3	6		
180	11	3	4			11	0	21			13	2	7		
190	12	1	21			11	3	7			14	1	7		
200	13	0	11			12	1	20			15	0	7		
210	13	3	0			13	0	6			15	3	7		
220	14	1	17			13	2	19			16	2	8		
240	15	2	24			14	3	19			18	0	9		
252	16	2	0			15	2	18			18	3	26		

	lb.	oz.	dr.		C.	qr.	lb.
N. B. A gallon of spirits at 1 to 5, weighs	7	8	15,	and a tun	17	0	1
Ditto .... at 1 to 3, weighs	7	7	6,	and a tun	16	3	3

METHOD OF CASTING A RECTIFIER'S STOCK.

Number of Casks.	1	2	3	4	5	6	7	8	9	10	11
Strength of Spirits in each Cask.	Spirits of Wine.	Over Proof.			Proof.	Under Proof.					
		1 to 20	1 to 10	1 to 15		1 in 6	1 in 5	1 in 4	1 in 3	1 in 2	2 in 3
Quantity of Gallons in each Cask.	9	656	690	—	65	—	1679	737	1306	174	231

1 to 20	1 to 10	1 in 5	1 in 4	1 in 3	1 in 2	2 in 3
20) 656	10) 690	5) 1679	4) 737	3) 1306		
32	69	335	184	435	2) 174	3) 231
688	759	1344	553	871	87	77

TOTAL OF PROOF SPIRITS COLLECTED.

Strengths.	Gallons.
1 to 20	688
1 to 10	759
Proof	65
1 in 5	1344
1 in 4	553
1 in 3	871
1 in 2	87
2 in 3	77
Total	4444
Multiplied by the Factor	1.3636
	54544
	54544
	54544
	54544
	6059.8384
Spirits of Wine doubled	18.

Total at 1 in 3 and ¾ ·· 6077. under Hydrometer Proof, according to G. III. c. 73.

Note.—Showing how to find the above factor. Divide 3.75 by 2.75, the product will be 1.3636, as above.

GENERAL RULES,

WITH

EXAMPLES,

For calculating Spirit of any given Strength, to ascertain its proper Quality of any other assigned Strength.

RULE I.

To bring the given strength to hydrometer proof, divide the given quantity by its given strength over or under hydrometer proof; if over proof, add the quotient to the quantity given; if under proof, deduct it therefrom, which gives the quantity at hydrometer proof.

EXAMPLE I.

Suppose 100 gallons of spirit at 1 to 10 over proof, what quantity of liquor will be necessary to reduce it to hydrometer proof?

10) 190
10 Liquor necessary.
110 Quantity when lowered.

EXAMPLE II.

Suppose 100 gallons of spirit at 1 in 10 under proof, how many gallons at hydrometer proof?

10) 100
10 Subtract.
90 Gallons at hydrometer proof.

RULE II.

If your spirit be of the strength of 2 in 3, or 3 in 4, &c. under hydrometer proof, divide by the last figure, and the quotient will be the quantity at hydrometer proof.

EXAMPLE III.

Suppose 92 gallons of spirit at 45 in 46 under proof, how many gallons at hydrometer proof?

46) 92 (2 gallons at hydrometer proof.
92

MIXING OF SPIRITS.

To find the value of a mixture of spirits multiply each quantity separately by its value per gallon; add the products together, and divide the sum total by the number of gallons in the whole quantity: the quotient will be the value of the mixture per gallon.

EXAMPLE.

I wish to mix 25 gallons of French brandy at 20*s.* per gallon, 20 gallons at 18*s.*, and 15 gallons at 12*s.*; what will be the value of a gallon of the mixture?

25 by 20 are £25
20 by 18 are 18
15 by 12 are 9
60 52
52
20
6|0) 104|0 (20
17*s.*

20
12
6|0) 24|0
4*d.*

Answer, 17*s.* 4*d.* per gallon.

To fill a Cask of 100 *Gallons with Brandy at* 16*s. and Brandy at* 12*s. so as to sell it at the rate of* 14*s. the Gallon.*

Given price . . .	14*s.*	Highest price . .	16*s.*
Lowest ditto . . .	12*s.*	Lowest ditto . . .	12*s.*
Difference	2*s.*		4*s.*

Given quantity . . 100
2
4)200
50

Thus I find, that in 100 gallons of this mixture there must be 50 gallons of the best brandy, and consequently 50 gallons of the worst.

I wish to know what strength the following spirits will be after they are mixed; namely, 120 gallons 1 *to* 10 over proof, and 56 gallons 1 *in* 5 under proof.

10) 120	5) 56
12	11 2
132 proof.	44 6 proof.

44 6
176 6 total proof.

Here I find, that 120 gallons at 1 to 10 are equivalent to 132 gallons at proof; and 50 at 1 in 5, to 44 gallons 6 pints at proof; which, added together, make 176 gallons 6 pints at proof; but as the whole mixture is only 176 gallons, it is consequently 6 pints better than proof.

Note.—I presume I have given sufficient instructions for mixing of spirits, &c.; therefore, I trust, no person will be at a loss how to calculate any mixture that may occur in business, with a little practice.

It must be observed, that it is found by experience, when spirits are lowered by the addition of liquor (particularly over proof spirits), or by being mixed with any other fluid of a more dense nature than such spirits, the mixture is not increased according to the quantity of liquor, or other fluid so added; but as the concentration or diminution in quantity will always vary in proportion to the quantities, weight, and temperature of the goods so mixed together; therefore this table shows that the deficiency occasioned by the mixture of water with spirits at the different strengths, by some called the concentration, is as follows:

Gallons.	Gallons.
75 to the 100 over proof	5
72½	4¾
70	4½
67½	4¼
65	4
62½	3¾
60	3½
57½	3¼
55	3
51½	2¾
48½	2½
45	2¼
41½	2
37½	1
33	1½
28½	1¼
24	1
19½	¾
15	½
10	¼

UNDER PROOF.

Gallons.	Gallons.
12 in the 100 under proof	¼
20	½
30	¾
40	1
50	¾
60	½
70	¼

APPENDIX.

DUBRUNFAUT'S
COMPLETE TREATISE
ON THE
Art of Distillation.

PART I.

In this Part we will treat of the various preparations to which vegetables are submitted, for the purpose of bringing them to the state of fermentable liquids, and we will also describe some of the instruments necessary for these preparations.

CHAPTER I.

Fermentable Vegetables.—Operations by which they are predisposed to Fermentation.

There is an immensity of fruits, of all kinds, out of which art teaches us to extract alcohol, but there is none that can undergo the spirituous fermentation in the state in which nature has produced them; all of them require to be submitted to certain preparatory operations, more or less complicated, and entirely depending on their nature.

The raisin, for instance, and all other fruits, containing sugar already formed, would not ferment at all, were it not submitted to the operation of pressing, which is requisite to tear its cellular tissue, and thus to set its juice at liberty. Even this juice would not ferment easily, if it was not fluid enough, that is, if the sugar it contains was not diluted in a sufficient quantity of water.

This species of vegetables forms a particular class in the distiller's art, because the operation to which it is to be submitted, before the fermentation, is purely mechanical. It consists, in fact, in bruising the tissue of the vegetable, and in adding water to the juice, in case the former of these bodies were not connected with its composition in sufficient quantity to render the alcoholic decomposition the most prompt and perfect possible.

We will form a separate class of such vegetables as require more complicated operations. Such is corn, which is but slightly fermentable, without undergoing an operation, the object of which is to convert its starch into sugar. Such are also potatos, which would not ferment at all if the fecula they contain was not submitted to the same metamorphosis. The latter class will comprehend all farinaceous vegetables which may be the object of distillation.

A particular chapter will be consecrated to each of those two classes, together with the operations they necessitate.

CHAP. II.

Vegetables belonging to the First Class.

It is a principle well recognized in our days, and entirely consecrated by practice, that all bodies containing sugar pass easily to the spirituous fermentation, when the necessary conditions for such a decomposition are, moreover, fulfilled.

Hence, the possibility of producing spirits from an infinite number of vegetables. Every clime of the two worlds has its fruits; nature has created sugar on all the inhabited points of our globe; and if she has more particularly favoured with this production the countries situated under the equator, she has not treated any sparingly, and man finds everywhere fruits and roots containing sugar.

Sugar is an element indispensable to the production of alcohol, and where it is absent, no vinous fermentation can take place.

Although it is possible, in virtue of this principle, to make spirits from an immense number of vegetables, yet, those only are used, who, by their abundance, their value and their produce in alcohol, can enter into competition in commerce. The spirits produced from them should be offered at a price equally low, unless peculiar circumstances legitimate the difference of their respective values. These may infinitely vary, according to time, place, and taste of the people: so it is, for instance, that the spirits of the raisin and rum may, under different circumstances, have a venal worth widely differing.

Although the quality and flavour of the spirituous produce of certain vegetables, not abounding in nature, may render them preferable to others, yet, those of more common use, will always supply trade with the greatest part of the spirit consumed; and, in this respect, they must be more proper to offer speculative elements to distillation.

We will then more specially turn our attention to such vegetables as form the basis of numerous establishments; and, after having done so, in a particular way, we will pass slightly over such as might be the object of distillation, although seldom used, till this day, unless by chemists, or as a matter of curiosity.

Section I.

CHERRIES.

From cherries is produced that kind of spirit known by the trade under the name *Kirsch-wasser.* This name comes from the German, and is composed of two words, signifying water of cherries. This liquor is scarcely made anywhere but in Switzerland and in Germany, where cherry-trees are very common, and that consumed in France comes from the neighbourhood of the *Forêt Noire.* The way of preparing the worts is as follows:—

In the month of July or August, when cherries are arrived to maturity, no trouble is taken to pick them, and they are brought down by means of poles, which is decidedly a vicious practice, leading to endamage the trees; and the cherries are accompanied by leaves and branches; which, gathered by children, are deposited in troughs made of osier, without any precaution, so that those that are spoiled, and those that are not quite ripe, are all mixed together.

This trough represents a cube or cylinder, more wide than deep, and yielding nearly two hectolitres, according to the extent of the fabrication. It is placed above the fermenting back, on two girders, which rest on the borders of the back, and are joined together by two cross pieces of the same thickness.

This trough being half or three-quarters full, men, women, and even children place themselves round it, and proceed to the pressing of the cherries, with their hands, so as to set the juice at liberty. This cannot be done perfectly, as it may well be supposed, by squeezing the cherries between their hands, or by rubbing them against the sides of the trough. The juice runs then in the fermenting back through the interstices of the trough, while skins, stalks, and stones are left behind.

The stones are then added to the liquid, and the wort is left to ferment.

It was thought for a long time, that it was necessary to break those stones, from which the kirsch derives its characteristic flavour and aroma, to obtain this effect; but experience has, in a concluding manner, demonstrated that this practice is useless, and that the worts from cherries fermented with the stones, either entire or broken, give an equally good flavoured *kirsch*.

Kirsch being only consumed as a *liqueur*, the fabrication of it is not considerable, and the wine producing it is put to the still immediately after the fermentation, which lasts from six to eight days. The areometrical density of the wort varies, according to years, from five to seven degrees: leaven is connected with its composition.

Section II.

SUGAR-CANE.

The sugar-cane, so useful to man, and which, in our days, has in its possession to supply all the nations of the two worlds with solid sugar, was known by the ancients, according to the evidence given by Theophrastes, by Plinius, &c.; but this sort of sugar, which had been sent to them by the Indies and by Arabia was so scarce, that it was only used as a medicine.

It was merely at the epoch of the crusades, at the time of the irruption of the Europeans into Asia, that the latter were acquainted with the sugar of the cane, which was obtained either in the solid or liquid state; and, from this moment, they were disposed to extend the culture of the cane, and to introduce it into all the countries where it would be likely to prosper.

In fact, this plant, originally belonging to the East Indies, had been brought by the Arabs into their country as a part of their conquests. From hence it passed into Egypt into Syria, into the islands of Cyprus and Candia, and into the Morea. The Europeans took it from there into Sicily, Calabria, Provence, Madeira, into the Canary Islands, and, at last, into America, where its culture has been so much developed.

The sugar-cane is cultivated in almost all the regions situated between the tropics, but more particularly in Guadaloupe, Havannah, Jamaica, Brazils, in China, and in all the Indian colonies. Its culture presents little difficulty; it belongs to the class of reeds; and prospers well in a slightly damp soil; too dry a ground renders the juice too heavy; and to work it well, in this case, it is necessary to mix it with that of the watery cane, grown in swampy soils; this mode is adopted at St. Peter, in Martinique, otherwise it must be diluted in water to clarify it.

The length of time the sugar-cane requires to be exposed to a warm temperature to ripen, is the cause of its not prospering in France, where, in Olivier de Serre's time, an attempt was made to grow it in Provence. The object of this culture is the production of concrete sugar; but our soil could only bring forth a kind of mucous sugar, its growing being suspended by the colds of the winter.

MOLASSES.

This name is given by the trade to the water resulting from the purifying of sugar.

The working of the sugars in America and the Indies, produces considerable quantities of molasses, the greater part of which is made into rum, by fermentation and distillation.

The French sugar-bakers produce great quantities of molasses, which have, sometimes, been used by the distillers, when the price of spirit happened to be high. A kind of molasses is extracted from the sugar of beet-root (mangel-worzel), the only use of which is distillation. We will treat of each of these species of molasses, and of the various processes by which they may be converted into spirits.

COLONIAL MOLASSES.

These furnish to commerce the spirituous liquors known by the name of tafia and rum.

The process made use of in the colonies for the production of these articles, is very imperfect, as also the apparatus used for the purpose of distillation.

This is their mode of working:—

The molasses are diluted in large tubs, so as to bring them to ten or twelve degrees density. These mixtures are made without paying any regard to temperature, because the heat of the climate is sufficient to cause fermentation, and are left to themselves; but those countries not possessing any artificial leavens, and that, connected with the composition of the sugar-cane, having lost its properties during the operations of boiling and defecating, requisite to separate the sugar, the worts enter with difficulty into fermentation; and very often they only arrive to this period, several days after their preparation. This is not the only difficulty attending their fermentation; for, after it has been established, its progress is very slow, and it requires from eight to fifteen days to bring it to the last period. These disadvantages, specially resulting from the absence of leaven, generally cause their spirituous products to be very small.

The distilling apparatus made use of in the colonies, is constructed on the same principle as that of simple distillation, described hereafter; it is, as will be explained in another part, the most imperfect and the least economical.

It often happens that the planters do not deprive their worts of all the spirit contained in them. This method is not very vicious in their way of working, because they use their spent-wash in the mixing of molasses. They have observed that the little portion of alcohol that is left, brought back again to fermentation, had very good effects. This remark may not be destitute of foundation; and it would not in the least astonish me, if alcohol added to a fermentable liquid, had an effect similar to that of leaven. It would be desirable some intelligent distillers turned their attention to some inquiries on that subject.

Besides, be the accuracy of their observations on the influence of alcohol, as a leaven for fermentation, as it may, at all events, the practice deduced from these remarks is not founded on good reasoning, and leaves much to desire for its perfection, and I doubt not but what they would obtain better results from the following method:—

The molasses should first be diluted with water or with spent-wash little acidified, so as to give them no greater density than from five to six degrees, and care should be taken to establish the temperature, from the beginning of the working, between twenty and thirty degrees Reaumur. To render the fermentation more active, one of the artificial leavens prescribed hereafter might be prepared, or the simple addition of a small quantity of the raw juice, made to ferment separately, would, in this case, be a powerful fermentative agent. I am convinced that, by this method, the fermentation would be much sooner established, would pass more rapidly through its different stages, and cause the spirits much to increase in quantity.

The spent-wash might be used with greater success in the subsequent brewings; for, in fact, it would be much less acid, proceeding from fermentations much less laborious.

The rum from the colonies acquires not, immediately after distillation, that flavour which we know it to possess; the acrid taste which it has on leaving the worm, is corrected by keeping it a long time in the barrels filled before with molasses; the former impregnated with syrup, seconded by time, operate this change in the flavour of the rum.

SUGAR-BOILERS' MOLASSES.

These molasses ferment with difficulty when alone. I recommend the same process to bring them to fermentation, as for the colonial molasses; and I must insist on some leaven being employed, that of beer, if it can be procured. As to the rest, the same course of working is to be followed. It might even be possible to obtain good results, by applying to these molasses, the various processes which I am about to describe, for the molasses of beet-roots. Experience must decide in this instance.

Section III.

BEET-ROOT.

The presence of sugar in a vegetable body is sufficient to evince its fermentable properties, and, of course, the possibility of drawing spirits from it. This discovery once made, we have only to learn by experience, whether an undertaking on such a basis would be attended with benefit.

For a long time we have been acquainted with

Margraff's discovery of the beet-root possessing a certain matter, which is saccharine and can be crystalized, but we have kept within those limits, without applying it to industry. Not long ago, when isolated from America and the Indies, who were in the exclusive possession of supplying us with all the sugar we wanted, we were induced to try many experiments, and speculation and privation contributed greatly to increase our exertions. Sugar had risen to an enormous price, and we found ourselves at the eve, not only of seeing it increase more and more, but even of being entirely deprived of a substance which habitude had turned into real want. Henceforth all our attention was directed towards an object, surrounded by numerous encouragements. The favour of government, the recompenses that were promised, and public utility, suscitated an immense number of trials, in which the most enlightened and the most recommendable men of the age participated. Margraff's discovery was exhumated, and immense fortunes were swallowed in transforming a laboratory experiment into a manufacturing operation.

The sugar of the beet-root is identical with that of the cane, when it is refined; consequently, it is quite as fine, and as good, and does not stand the farmer above forty centimes per five hectolitres on an average of years.

The production of solid sugar in the beet-root, as all other vegetable products, is subject to agricultural chances. Some years are more favourable to it than others; but an intelligent manufacturer, thoroughly acquainted with his art, will always escape great losses in a more or less fortunate way. So it is, for instance, that a manufacturer of beet-root sugar, finding, in unfavourable years, that the small quantity of sugar which the vegetable gives him, would not defray his expenses of fabrication, meets with a precious resource in submitting it to distillation.

The choice of the beet-root, either to make sugar or to produce spirit, is not more indifferent in one case than in the other. There exists a great variety of them, all of which are distinguished by the colour of their peel and that of their pulp. The white, the yellow beet-root, and that which is white inside and red outside are preferable to all others. Whatever be the colour of the root, it is essential to appropriate it to the soil, to cultivate it in a fit and proper manner, and not to use the seeds of degenerated species. Experience has proved the steaky beet-root to be the least productive, and must, of course, be rejected as much as possible.

The beet-root thrives in mixed soils, by this is meant such as are not too mobile nor too argillous, neither too calcareous nor too sandy. The soil should not be too damp nor too dry. It grows well after black oats, and all sorts of manures, sparingly distributed, are suitable to it, however, strawy manures and the stalling of herds are more proper for it.

It is generally sown in the month of April, and reaped towards the end of September, or in the beginning of October, according to the climate. The soils of the north and centre of France seem to be more favourable to this culture than those of the south.

As soon as the beet-roots are drawn out of the ground, they are necked and warehoused where the frost cannot injure them, in cellars or in pits digged four or five feet deep, covered afterwards by a couch of soil, from one to one and a half feet in thickness.

Then they are taken as they are wanted, and their juice is expressed, by means of Burette's or Odobel's rasp, both of which we will describe.

BURETTE'S RASP.

It will be sufficient for the purpose of giving an exact idea of this rasp and its effects, to produce the report made to the Society of Encouragement, by Mr. Pagot-Descharmes, in the name of the Committee of Mechanical Arts.

" The attention of mechanics has for a long " time been directed towards the means of ob-

" taining the fecula from potatos, with economy " of time and of manual labour. Although their " emulation has often been strongly seconded by " circumstances, the first system of rasps known, " that of the tin rasp, filled with holes, is the only " one that has been followed. Mr. Burette, " whom a long experience has convinced of the " imperfections of that instrument, with regard " to the nature of the pulp of potatos, seems to " have been the first who felt the necessity of " taking another direction. The machine of " which we are about to give a description to " the Society, is the fruit of this artist's medita- " tions.

" A frame made of oak, built strongly, having " an oblong form, mounted on four legs joined " together from top to bottom by cross pieces, " constitutes the assemblage bearing the various " parts of the new mechanism, nearly all of them " disposed on the length of the upper cross " pieces. Those parts are composed of a wooden " cylinder, made plain and suitably prepared; " its diameter is eighteen inches, and its breadth " eight inches; its circumference is armed with " eighty saw-blades, seven inches long. On one " of the extremities of the axis of the cylinder is " an iron pinion, furnished with sixteen teeth, " working in those of a wheel, also of iron, and " having a hundred and twenty teeth; a handle

" of eighteen inches is fixed on each extremity of the axis of this wheel. Under this " cylinder is placed a kind of trunk, inclined in " such a manner as to send the pulp obtained in " a bucket, filling the functions of a recipient; " on the same face of the frame and before the " circumference of the cylinder, is adjusted, on a " mobile centre, a kind of wooden shutter, which " receives from the axis of the pinion, and by " the aid of swing gates, a to-and-fro motion, in " such a manner as alternately to open and to " close the interval left between the cylinder and " that same shutter, for the passage of the potatos. Nevertheless the opening is limited, by " means of a little bar, on which the shutter " rests in its back motion. All the parts of this " machine, exceeding the frame, are enveloped " in a box, surmounted by a hopper, yielding " about a quintal of potatos. From this kind " of cage results that the trituration is effected, " very properly, without splashing or loss of " matter. Two thousand five hundred kilogrammes of potatos may be reduced, in twelve " hours, by this rasp, worked by two men. Its " value is four hundred francs."

ODOBEL'S RASP FOR BEET-ROOTS.

This rasp is of a different construction to that of Burette's. That part which is armed with saws, and which, by its rotatory motion, divides the vegetable, is made in a conical form. From seven to eight thousand kilogrammes of beet-roots may be rasped by it, in twelve hours, by a power equal to that of two horses. Its value is twelve hundred francs.

The pulp is then placed on the cloth of the cylindrical press; or which is much better, it is placed in bags, which are to be pillared and submitted to the action of a screwing or hydraulical press. This kind of press is preferable to any other, because it possesses the greatest force; by these means a quantity of the juice is obtained, proportionate to the energy of the machine made use of.

With a cylindrical press, well mounted and well conducted, it is possible to obtain a quantity of juice equivalent to seventy per cent. of the weight of the raw beet-root; to this effect, it is necessary to wet the residue of the first extract, and to submit it again to the action of the press.

With screwing or hydraulical presses, sixty-five, seventy, and even eighty per cent. of the juice can be obtained, in one operation, according to the power of the engine, or the more or less aqueous qualities of the roots.

This juice, supposing no water to have been used, may mark from 5° to 9° Beaumé, according to years, and the species of the fruit. It contains, like the cane, two kinds of sugar, one solid and the other liquid, that is to say, one that can be crystalized, and the other molasses; it contains, besides, water, leaven, and some extractive substances, one of which gives to the beet-root that acrid taste, by which it is distinguished, and also the property of attacking the throats of those who eat it: this is not even entirely removed, by the operation of boiling, as it may have been observed.

This substance might communicate to the spirits of beet-roots its noxious taste, was it not corrected by the operation of rectification, of which we will treat hereafter.

The liquid separated by means of the press, may be put immediately to fermentation; leaven enters in its composition, and soon begins to work.

A good soil may produce from eighty to one hundred thousand pounds of beet-roots, per hectare. In this instance, the thousand do not stand the farmer, after deduction of the costs and benefits of culture, more than five or six francs. In a favourable year, and with good instruments, one thousand pounds of beet-roots will produce seven hundred pounds of juice 9° gravity, which being diluted to 5° and fermented, will produce thirty litres of good spirit at 19° Cartier.

I am not aware of beet-roots having ever been cultivated for the sole intent of distillation. Scarcely any parts of this root, except the molasses produced by the extraction of its sugar, are used for that purpose. There is a greater advantage in first separating the sugar; and its raw juice has only been fermented, in unfavourable years, when the object of its cultivation, which is to produce sugar, could not be successfully fulfilled; in such case, distillation has offered a salutary resource. But we may judge, from what has already been said, that a farmer, not possessing the pecuniary means necessary to establish a sugar-house, might derive favourable results from the distillation of beet-roots.

MOLASSES OF BEET-ROOTS.

These molasses, as I have already observed, have not yet been applied to any other use than that of distillation. This results from their bad taste, which is the cause of their being rejected by the trade. In fact, they cannot be delivered to consumption in the state they are in, like the molasses from the sugar bake-houses; there is nothing of which the former partake less than of that luscious savour of the latter, and this is the only difference existing between the raw sugar of the beet-root and that of the cane, both of which are identical, after having been purified of their molasses. The molasses of beet-roots take with them all the acrity of the root, and moreover they happen very often to have a strong taste of salt, caused by the nitrate of pot-ash or salt-petre, which the beet-root contains in large quantities. However, notwithstanding the taste of these molasses, which, in appearance and in taste, are much less saccharine than those of the sugar-bakers', they are much preferable to the latter, with respect to the quantity of spirit they produce. The taste of the latter, it is true, resembles less that of rum, and keeps always a particular aroma; but it is one agreeable to the palate, and might perhaps, with certain precautions, be rendered more identic with that of the rum of the colonies.

METHOD OF MR. CAFLER.

This is a method to be followed in preparing beet-root molasses for a good fermentation. It has been communicated to me by one of my friends, Mr. Cafler, manufacturer of beet-root sugar, and distiller at Dorignies, near Douay. This enlightened manufacturer, whom I shall have occasion to name hereafter, submits to distillation all the molasses proceeding from his sugar-house; and, by means of the experiments he has made, to perfectionate his way of working, he has been able to recognize a great advantage in working in the following manner.

He mixes one hundred litres of molasses with one hundred litres of boiling water. When all has been well blended, he covers the back, and leaves the mixture to itself for twelve hours. Then he adds two hectolitres of boiling water, mixes the mass well, and lets it repose twelve hours longer. At this period he proceeds to the fermentation, and to this effect he dilutes the whole mass with cold and warm water, so as to bring it to the temperature required, and to give it from five to six areometrical degrees density. From one hectolitre of syrup he obtains from twenty to twenty-four hectolitres of well fermented wash, which renders him about eighty litres of spirits at 19°.

This quantity differs from those reported in various works. Mr. Chaptal, for instance, declares, in his excellent work on beet-root sugar, 1821, that the same quantity of molasses has only produced fifteen litres of spirits at 22°, nearly equivalent to eighteen litres at 19°. Mr. Matthew de Dombasle, on the contrary, assures us of having constantly drawn one hundred litres at 19° from the same quantity of molasses.

How can we account for two results so widely differing? I think we can explain it, by the admission of the fact, which is very probable, that Mr. Chaptal, by exhausting his molasses much more, renders them less fit for distillation, and that Mr. M. de Dombasle has always operated on molasses, richer in sugar, less exhausted, and with a better knowledge of that kind of work.

It is necessary to observe that the produce, mentioned before, of eighty litres of spirits at 19° from one hundred litres of molasses, is owing to the process which I have just described, for fermenting them. Mr. Cafler, before he made use of this method, was far from drawing as much from his molasses.

Moreover, I must warn the reader that one of the advantages attached to this mode of operating, results from the use of the spent-wash. This occasions an economy in fuel, as the caloric of the wash, leaving the still in a boiling state, is in this instance appropriated to good use. Besides, we find in the use of spent-wash all the benefits which I will hereafter develope, in treating of the most perfect transformation of sugar into alcohol.

Very often Mr. Cafler has found an advantage in adjoining grain to his mixtures, at the rate of from five to seven kilogrammes per one hundred litres of molasses. This grain, when broken and consisting of a mixture of twenty kilogrammes of malt to eighty of rye, gives more nerve to the fermentation, and renders it more complete.

METHOD OF MR. M. DE DOMBASLE.

I have just cited the astonishing produce of spirit Mr. M. de Dombasle has drawn from the molasses of beet-roots. The method followed by this distinguished technologist, to obtain such a result, will, no doubt, be read with interest. He has placed an account of it, with some illustrations, in the second edition of an excellent work, on the sugar of beet-roots. We will give some extracts out of it, which will be sufficient to show the particularities attached to his method.

" Supposing the fermenting back made use of " to contain fifty hectolitres; the quantity of flour " necessary to make the leaven will be eighty " pounds, and that of sulphuric acid will be ten " kilogrammes. The evening preceding the first " mashing, a leaven composed of forty pounds " of flour, half of the whole quantity should be " prepared; the following morning a quantity of " molasses should be let into the back, sufficient " to form, with the water that is to be used, a " mixture filling one-third of the back and " marking 7° density. The molasses being " poured into the back, a small quantity of boiling water should be added, and the mixture " should be agitated so as to be well diluted. " When the molasses are completely dissolved, " which requires time and labour, warm and

“ cold water should be added in such proportions
“ as to fill the third part of the tub with
“ liquid of 7° gravity and 27° temperature.
“ Then five kilogrammes of sulphuric acid should
“ be added, the mixture must be well agitated,
“ the leaven must be added, and this being well
“ mixed with the wort, the tub is covered. The
“ fermentation is soon established, and after a
“ few hours the surface of the liquid is covered
“ with scum.

“ The next morning another third of the tub
“ is filled, the molasses are first separately diluted
“ with warm and cold water, then they are let
“ into the fermenting tub, with the addition of
“ such a quantity of water as to bring the mixture
“ to the same degrees of density and of
“ temperature as the day before. Half of the
“ acid left is then added, this being well mixed
“ with the mass, twenty pounds of flour prepared
“ for leaven the day before are mixed with
“ it, and this mixture is carefully agitated as
“ before.

“ The following day the other third is filled,
“ the rest of the acid and of the flour is used as
“ before, and the tub is again covered.

“ If the operation has been well conducted,
“ the fermentation is not interrupted by the second
“ and third charges; but it gains on the
“ contrary much activity: the noise which it

" occasions is heard at a tolerable distance
" from the tub, and this only ceases when it
" draws to the end, which must take place the
" second or third day after the last charge.

" The wash is ready for distillation, when the
" scum is fallen, and the movement of the fer-
" mentation has ceased. The liquid should then
" mark from 1° to 2° density; if it marked more
" it would be a sign that the fermentation has
" been incomplete, but when the symptoms of
" its termination are once manifest, nothing
" could be gained by waiting, and every attempt
" to revive it would be useless. Generally when
" the fermentation has made little progress
" during its first stages, it languishes afterwards,
" so as to last four, five, or six days, or even
" longer. In this case it is necessary to wait,
" for I have always remarked that it becomes
" impossible to remedy this evil. Besides, this
" vitiated march is always the result of some
" error committed in the beginning of the ope-
" ration, supposing good materials to have been
" employed. When the vinous fermentation is
" at an end, a kind of effervescence is neverthe-
" less produced in the liquid, which persons of
" little experience often take for a continuation
" of the fermentation; but this movement is no-
" thing but the beginning of acetous fermenta-
" tion, and it is very important not to be de-

" ceived by it. This second fermentation pre-
" sents symptoms entirely different from those of
" the first: it is distinguished by the appearance
" of large bubbles rising, from time to time, on
" the face of the liquid, or by a shivering
" widely differing from that of the vinous fer-
" mentation. It is sufficient to observe atten-
" tively the march of two or three fermenting
" backs, to distinguish it. Degustation is also a
" good criterion to recognize the different stages
" of fermentation. The saccharine taste disap-
" pears as the fermentation advances; and when
" the latter is terminated, the saccharine taste
" is replaced by a vinous one, which is, in all
" well-conducted fermentations, remarkable for
" its bitterness. In the latter case, not the
" least taste of acidity is perceived, and the use
" of sulphuric acid presents the extraordinary
" circumstance, that the wine, after fermenta-
" tion, is much less acid than if none had been
" used; it appears that the acid must have been
" decomposed or has entered into a new combina-
" tion, to form the bitter and pungent substance,
" which the palate discovers in the wine."

The wine should be distilled as soon as the vinous fermentation is over.

By this method, Mr. de Dombasle assures us of having constantly drawn 100 litres of spirits at 19° from an equal quantity of molasses.

The use of sulphuric acid at the enormous dose of ten kilogrammes for fifty hectolitres of liquid at 7°, appears contradictory to the principles of vinous fermentation, to which the presence of acids is always obnoxious. But, it appears, that in this case the sulphuric acid does not remain unchanged in the liquid, and forms a bitter combination. This combination might possibly be sulphate of chalk, and this would explain the phenomenon without difficulty. In fact, beet-roots are nearly always treated with an excess of chalk, in their preparation for sugar. We know that chalk is easily dissolved into syrup; we know also that it is offensive to the developing of the spirituous fermentation. Now, if the combination of the acid with chalk took place in Mr. de Dombasle's system of working, the utility of the former would find in our chemical theory a satisfactory explanation.

CHAP. III.

Vegetables belonging to the Second Class.

We will range in this class, as we have already announced, all vegetables having little or no sugar among their immediate materials, and which may, nevertheless, by means of some preparatory operations, more or less complicated, produce a great quantity of alcohol. This class is composed of materials, the nature of which is essentially farinaceous, that is to say, in which the most voluminous element is fecula or starch.

The name of *fecula* is given to a substance which is white, crystalline, inodorous, and almost insipid, such is the fecula of potatos. The name of starch is more particularly applied to a substance analogous to fecula, the physical and chemical properties of which are almost identical with those of the latter. Such is the starch drawn from wheat and all other corn. We may then, in the distiller's art, confound under the same idea the words fecula and starch; and we will indiscriminately use one for the other.

It is to the fecula that all grains, potatos, and almost every vegetable of this class owe their nutritious properties; and the more fecula they contain the better they are liked for food. It having once been recognized that sugar possessed the exclusive property of undergoing the vinous fermentation, and, consequently, of producing alcohol, by distillation, our chemists extended this principle, without exception, to all other vegetables, admitting only the production of alcohol, in the distillation of corn and of potatos, as proportionate to the quantity of sugar which they contain. It is clearly demonstrated now that neither corn nor potatos contain any sugar at all, and the fact proves, on the other side, that they can undergo the vinous fermentation.

Experiments well made and unexceptionable having since demonstrated that fecula can be converted into sugar, by various means, every thing, in the distillation of farinaceous vegetables is explained, without subverting the theory of the conditions necessary to the formation of alcohol. So it is that in all arts, practice often precedes all theoretical rules, and that the manufacturer, far removed from the observations of the learned, may create for many years, before science has the least suspicion of such creation. Indeed, grain and potatos were distilled, long time before the chemical doctrines admitted the possibility of the fact.

It will not be useless to signalize here the various discoveries which have led to the conception of all the operations now in use to bring the fecula to the state of sugar, and give it by these means fermentable properties.

Kirchoff, a celebrated chemist at St. Petersburg, was enabled, by means of sulphuric acid, of water, and of an ebullition, lasting about thirty-six hours, to convert fecula into a kind of sugar, half liquid and half solid, which, placed under favourable circumstances, passed to fermentation, in the same manner as all the bodies containing sugar which nature has provided for us. This experiment of Kirchoff has been transformed, in France, and particularly at Paris, into a manufacturing operation, easily practicable. We will hereafter indicate the practice of this operation.

The same chemist has proved that starch converted into paste, diluted with eight or ten times its weight of water, mixed in that state, with its weight of dried and pulverized gluten, and exposed for twelve or fifteen hours, in a stove, to the temperature of 50°, can be transformed into a kind of sugar, similar to that obtained by the concurrence of sulphuric acid. The gluten employed in this experiment, as the vehicle transforming the fecula into sugar, is a substance which presents a membranous aspect, whem impregnated with water: when dried it resembles very much to the gelatine, known under the name of Dutch transparent glue. The proportion of gluten contained in corn varies; wheat contains the greatest quantity of it; it is that substance which envelopes the fecula of corn and renders it proper for baking. In fact, pure fecula, that of potatos for instance, cannot be made into bread; and if wheat has, over all other grain, a remarkable superiority, for the purpose of baking, it is owing to the proportion of gluten which it contains.

If corn did not contain this peculiar substance, the fecula might be isolated from it, by the same process as that used to extract it from potatos; this consists in a simple reduction and a few washings to take the fecula away; but this is not the case. Indeed it is well known that the first operation of the starch-makers is to destroy the gluten, and by this means to set the fecula at liberty; from this moment the operations of the starch-maker become analogous to those of the feculist, so that to separate the fecula from the corn, it is sufficient to wash the latter; the former is delivered to trade under the name of starch.

To destroy that gluten, the starch-makers deposit their wheat, reduced to flour, or only the bran of wheat, in large cisterns, where it is diluted in a mixture of fresh and sour water. A fermentation is established and gas is discharged; there is also formation of acetic acid, or vinegar, which has the property of dissolving the gluten; the starch becomes free by this operation, and can easily be separated. Let us not lose sight of this property of the acetic acid, it will be of use to us hereafter, in the explanation of the phenomena that take place during the fermentation of corn.

Gluten may easily be separated from the flour of wheat, but as trade cannot find any use for it, it is seldom prepared. If one would form an exact idea of its nature, and isolate it, it would be sufficient to take flour of grain of any description, but that of wheat is preferable. First, it is to be converted into a paste; then it is malaxated with the hands, while a continual stream of water falls on it. This water runs very white at first; that colour is given to it by the fecula, which it takes away. When the water runs clear, it is not necessary to malaxate any longer, and what is left in the hand is pure gluten. The discovery of this substance is owing to Beccaria, an Italian chemist.

The discovery of the property which gluten possesses of saccharifying the fecula (converted into paste) by a protracted concurrence of water and heat, threw great light on the distillation of corn. In fact, until then it had been held impossible to account for the transformation of starch into sugar, in the distiller's art; and from that moment it was supposed that this property was owing to the gluten.

M. de Saussure has also made curious experiments on the saccharification of starch, and this learned and recommendable chemist has proved, beyond doubt, that starch converted into paste, and abandoned to itself for a time, more or less considerable, was metamorphosed into sugar, more or less completely, according to the length of time it had been left to itself. This discovery has not yet been applied to practice; but we may hope that it will lead, sooner or later, to some solution useful to industry.

The same chemist, on studying the discovery of Kirchoff, on the conversion of starch into sugar, by means of sulphuric acid, is the first who has given a theory of it, which appears to me unexceptionable. He has demonstrated that the sulphuric acid was not decomposed in this experiment, and that the starch found the elements of its transformation in the water with which it was mixed in the state of paste.

This theory of the saccharification of starch is not only applicable to all cases, where the latter is converted into sugar, but even to those where it is in a corrupt state.

Section I.

CORN.

Corn has, for many years, supplied trade with a kind of spirits, generally known by the name of spirits of corn.

Among the various kinds of corn, used for the purpose of distillation, rye takes the first rank; oats and wheat are sometimes used with success; barley is almost always mixed, in a proportion which varies, with those vegetables.

CHOICE OF CORN.

We know of no other way of ascertaining the venal worth of corn than that of its specific gravity, so that, *cæteris paribus,* that which under an equal measure, an hectolitre, for instance, weighs the most, must be preferred for distillation, as well as for every other use: and the price varies particularly according to this quality.

It is not indifferent to neglect the other qualities: such as their perfect conservation, because those that are heated render much less spirit, their fermentation not being so good.

As to the defects inherent to corn, which agricultural chances have occasioned to germinate before the harvest, these are recognized by the appearance and weight of the corn: it weighs much less than that which has not undergone this change.

Wheat is seldom used for distillation, because, destined for human food, its value is generally greater than that of other corn, and because its produce in spirit is not proportionate to that value. Oats, for the same reasons, are seldom used for distillation; besides, they are useful to feed horses.

Rye is the most convenient, because its produce in spirits is considerable, and also, because it leaves a proper margin to the distiller. Besides, being little fit for baking, it would find very little use without distillation.

As to barley, it acts a part in the fermentation which has not been studied till this day, and which gives to its use, combined with other grain, a utility consecrated by practise, and which we will substantiate in proper time and place.

Let us now go through the various methods followed to bring corn to fermentation.

Section II.

OPERATIONS WHICH ARE INDISPENSABLE TO THE FERMENTATION OF CORN.

There are many methods for predisposing corn to fermentation, but whatever be the shades of differences variegating those methods, there exists three operations common to all.

These three operations are practised in all distilleries. The first is that of grinding, the second is that known under the name of steeping, and the third that of mashing. They are of such importance in the distiller's art, that I think it necessary to describe them separately, and to indicate, at the same time, their object and utility.

GRINDING OF CORN.

Every species of corn destined for distillation should not be ground into fine flour, but only broken. This is a practice of which experience has proved the utility. Not that a greater division of the vegetable would be an obstacle to fermentation, when the following preparations are also made use of; but these preparations would then be of a more difficult workmanship, and expenses of grinding would be much heavier. These inconveniences may be avoided, by only reducing the corn into coarse flour. This result is obtained by having the mill-stones at a proper distance one from the other. It is customary in distilleries to use the corn as it is wanted. This, in fact, keeps better in its natural state; it is less liable to be heated; and by these means requires less precautions to be taken for its preservation. I would advise distillers to follow this method, if they wish not to be exposed to great decrease in spirits: corn heated either in nature or when reduced to flour, loses its fermentable properties.

STEEPING OF THE FLOUR.

Let us suppose, for the most perfect intelligence of this operation, the quantity of matter to be fermented to be equal to one hundred kilogrammes. The corn being selected and ground into coarse flour, is deposited in a tub capable of yielding seven hectolitres of matter, but to be filled only with six, so as to keep a vacuum necessary to the scum produced by the fermentation. Then proceed to the steeping; it is effected by pouring on the flour one hectolitre, or what is the same thing, one hundred kilogrammes of water at 35° or 40°, according to the season of the year; the water should be hotter in winter than in summer; and the best mode of working is to pour on the flour a mixture of hot and cold water, such as to form, after ten minutes' brewing, a mixture at 25° or 30°, which will easily be obtained in all seasons; to this effect the use of the thermometer should not be neglected, it is an infallible guide to conduct this operation regularly. In this state, when there are no lumps that have escaped the penetration of the water, and when the mixture has been agitated for ten minutes, the tub is left to subside for half an hour; one quarter of an hour is even sufficient. The object of this operation is, as its name indicates, to steep and soften the grain, by making it absorb water: and the temperature of 35° or 40° contributes to render water more penetrating, consequently it has been recognized the most proper for steeping. If the temperature was lower, its effects would be much slower, and after a quarter of an hour or half an hour's rest, the corn might happen not to be sufficiently steeped. If it was higher, on the contrary, the corn would be apt to be baked, and the operation might fail; such would be the effect of a temperature of 60°. At this heat, the fecula enveloped with gluten is baked to the surface of each fragment of corn and forms a solid envelope, which presents an obstacle to the easy penetration of the water into the interior parts of each of the fragments, and this penetration should indispensably take place before the commencement of the following operation; a real harm results from not proceeding in such a way as to effect it.

It is also essential, in the beginning of this operation, not to pour at once into the tub all the water necessary, and the operation will be always well conducted when the water arrives gradually, during which time the flour should be well stirred.

These rules, which I have just established for steeping, are general, and admit of no exceptions, whatever be the nature and state of the grain made use of.

MASHING.

The steeping of the flour being finished, the next operation is that of mashing. This consists in well brewing the grain which has been steeped, while a quantity of boiling water arrives gradually into the tub, till the mixture has acquired 50° or 55°. The agitation should last five minutes at least. At this period the tub is covered and left to subside for a space of time, varying from two to four hours. We can lay down as a principle, that the longer the mixture is left to itself, the more complete the operation will be; that is to say that four hours' standing is always better than two. Nevertheless, it would sometimes be more injurious than beneficial to extend this space of time; such would, for instance, be the case if the mixture descended below 35°.

This process will always be well executed, if conducted in such a manner as not to allow the temperature of the mass, during a mashing of three or four hours, to sink below 40° or 45°. To this effect the tub should be carefully covered after the brewing is over. But it may easily be perceived, that whatever precautions be taken to avoid the loss of heat, it will always be very considerable in the space of a few hours, even if there was none sustained but that occasioned by the sides of the tub. The smaller the mass operated upon, the greater this loss will be, and *vice versâ*. It will always be greater in the winter than in the summer, so that the talent of the distiller, for mashing, consists in knowing how to use the thermometer: for instance, he will give a little more heat to a small tub than to a large one, say 55° to 57° to a tub of six hectolitres and upwards as high as twelve; and 50° or 52° to tubs of greater dimensions; he will also increase the heat a little in the winter, and lessen it in the summer; and in all cases, the lob must be put to fermentation as soon as its temperature is fallen to 35°; should he wait longer, he is exposed to have the whole mass spoiled by the acetous fermentation, which is easily developed at that temperature.

During the subsiding of the maceration, a phenomenon takes place, which was never suspected before the experiments I made on that subject, and which have a place in my memorial already mentioned; indeed, I have recognized that this repose practised in distilleries, under the name of maceration, had for object to saccharify the fecula of grain, and to predispose it thus to a fermentation, which it could not undergo without it. In fact, if corn, taken in a raw state, was simply diluted with water at 30°, to form a mixture bearing from 20° to 25° heat, the most proper temperature for fermentation, the latter would never be developed, or, at least, it would only declare itself after a many days, and that with very little intensity. It is not the case, when the mashing has been well conducted, and the more favourable the conditions under which it has been executed, the better the fermentation will proceed.

We may then consider mashing as a real saccharification; and, if we remark the analogy between the saccharification of grain and Kirchoff's experiment, by which he has converted starch into sugar, by means of water, gluten, and a temperature of 50°, kept up for twelve hours, the saccharification of the fecula of corn, during the mashing, will easily be conceived. In fact, all grain contains gluten, with which the starch is in immediate contact. Water is added during the operation, and the mixture is exposed to a temperature of 50°.

The most proper temperature for mashing is that of 50°: by this heat starch is converted into sugar in the shortest space of time. Not that this effect could not be obtained at a lower temperature, 30° for instance, but then the mass would be in danger of turning acid, and if this temperature was to be maintained for some hours, the evil resulting from it would be irreparable. If the temperature exceeded 50°, there would be no inconvenience to bring it to 55° and even to 58°, but at 60° the danger begins to show itself, above 60° there is great danger of doing harm to the fermentation, and if the heat approached 80° there would be no fermentation produced at all. It appears that the gluten, which in this operation is the vehicle of saccharification, only possesses that property when it has not been exposed to too high a temperature, heat seconds its action very much, and renders it more intense; but, I repeat it, the maximum of this heat is from 50° to 58°.

The proportion of water acts also a remarkable part in the maceration, and the greater the bulk made use of, the more prompt and complete the saccharification will be, all other necessary conditions being fulfilled: for instance, generally to work one hundred kilogrammes of flour, one hectolitre of water is used in steeping, and two and a half are added in mashing; this will be complete in four hours. But, if the dose of water was doubled, that is to say, if three hectolitres were used in steeping, and four in mashing, this mashing might be as complete as the former in the course of from two hours to two hours and a half; such is the influence of water on the saccharification of starch.

We will hereafter finally demonstrate those various phenomena, by other examples; we shall particularly have occasion for this demonstration when treating on the maceration of potatos, when we shall describe those tubercles.

When the mashing is over, that is after two or four hours, according to the quantity of water made use of, a temperature bordering upon 50° having been maintained, then the liquid is put to fermentation; this is done by adding to it a new quantity of water, so as to have the mixture well diluted. I shall not fix this proportion of water, because it depends on that used in steeping and mashing; but, in all cases, it must be formed of a mixture of cold and hot water, such as to give to the liquid a temperature of from 15° to 20°, according to the bulk operated upon, leaven is then added, and the fermentation is soon established.

Section III.

MALTING.

We have signalized, in the preceding section, the operations common to the various methods made use of to predispose corn to fermentation, and which always take immediate precedence over the latter; but it often happens that corn, intended for distillation, is submitted to a previous preparation, known by the name of malting. I am not aware of the existence of any distillery where raw, that is, unmalted corn, is used for the purpose of distillation. The French and English distillers always mix their raw grain with a certain portion of malt, and a great many German distillers work entirely with malted grain. It will thus be essential minutely to indicate the best processes practised in malting.

This operation is composed of several others, which I will successively describe.

STEEPING.

The corn is thrown into a tub in such quantity as to fill seven-eighths of its contents. Then a quantity of fresh water is poured on the grain, so as to cover it a few inches. The quality of the water made use of is not indifferent, it is essential it should be fresh and limpid.

The object of this operation being to soften the grain, by impregnating all its parts with water, a space of time is requisite proportionate to its dryness and temperature, so that it is less penetrable in winter than in summer, when old than when new; and, to regulate the time necessary to this operation, a fixed period ought not so much to be taken for basis as certain signs easily recognized. We may always be certain that the corn has been sufficiently steeped, when, on being strongly rubbed between the hands, it is completely crushed without leaving any solid or irreducible particle. All the other means resorted to to recognize the period of its termination are analogous to the latter; such is, for instance, that of cutting it by the nail, or crushing it between the teeth; by these means and a little practice, we may always convince ourselves that not the least particle of corn has escaped the penetrating and softening action of the water; for this is the only object of steeping.

To guide the practitioner we will inform him that the grain is sufficiently softened and penetrated, after having remained from thirty to forty hours in the water, according to the season and the materials made use of. We will also caution him that it is sometimes necessary in the heat of the summer to renew the water once or twice, because, without that precaution, a fermentation might take place, which would always prove injurious to future results.

When the corn has been sufficiently softened, and is placed under one of the conditions necessary for germination, it is extremely swoln and increases conspicuously in bulk; this is the reason why we have recommended not to fill the back entirely. Then the water is let out of the back, through an opening made in the lower part of it, and continues to be drained for ten or twelve hours previously to the succeeding operation, the object of which is to cause the grain to germinate.

OF MALTING, PROPERLY SPEAKING.

The corn having been suitably steeped, in the way above described, is placed on the malting-floor, near to which the steeping-back should be placed, to save labour as much as possible. It is placed in a heap on the floor, and left to itself until it becomes palpably warm; this heat is produced by the grain beginning to work, and generally declares itself from twelve to twenty-four hours after it has been committed to the floor. At this period it is disposed in lays of from four to six decimetres depth, according to the calorific state of the floor; the temperature of 12° is the most suitable to this operation. In such case the lays may be five decimetres in depth; they are laid thicker when the temperature is low, and thinner when it is more elevated.

The influence exercised by the thickness of these lays on the progress of the germination of the corn is very great, with respect to the heat which this thickness may contain; and from this principle we must conclude that, without heat, no germination would take place, and that, from the moment the watered grain has gained the temperature of 12° or 15° for instance, it begins to undergo an internal alteration, which produces heat itself; from hence it will easily be conceived that this heat is better retained by a thick lay than by one that is thin; and on this observation is founded the principle which I have emitted on the variation of the thickness to be given to the lays on the malt-floor.

This kind of fermentation, thus established in grain placed under favourable conditions, soon produces at the end of each grain, and particularly of those that are in the middle of the lay, a white point, which is a sign of the commencement of the germination. This point appears generally twenty-five or thirty hours after the grain has been placed in lays. At this period it is important to turn the grain, so as to place, at the bottom of the lay, that which was uppermost before; this effect is obtained by removing it to another part of the floor, by means of a wooden shovel. It would greatly improve the quality of the malt to submit the grain to this operation once or twice before the appearance of the white point. The object of this is to regulate the heat of the whole mass, so as to place all the parts of the grain under circumstances equally favourable to germination, and thus to cause the movement to be simultaneous. The heap being thus turned, the white point observed in the grain comes out, and presents extricated fibres, which are nothing but the growing roots of the plant. Then it is more important than ever to mind the grain, to remove and turn it frequently, as we have before recommended, so as to regulate the germination. This management is essentially necessary; for, without it, an unequal heat would reign in the mass; this would occasion the roots to grow unequally, and it would be impossible to fix a determinate time for the term of the germination; this operation is generally at an end when the fibres have acquired a length of six or seven lines: then the decomposition of the corn is come to a point which has been recognized as the most favourable to malt, because, at this period, the plume which is to form the stalk of the plant is on the point of making its appearance; and if the operation were any longer protracted, so as to give to this plume the time of shooting out, the malted grain would lose a great part of the substance useful to the production of spirits.

Germination provokes in the corn a change particularly favourable to the success of the mashing: it becomes sweetish, and this taste is owing to the saccharification of a small portion of the fecula, or starch; the gluten is partly destroyed, and that which is left becomes soluble, in water, from insoluble, which it was before the germination had taken place: by these means the fecula is set at liberty, and the gluten, having become soluble, possesses properties much more energetic than when in its natural state.

The object of malting is then to convert into sugar a small quantity of the fecula of the corn, and to predispose, at the same time, the rest to a saccharification more complete and prompt, by giving to the gluten the property of being dissolved.

All the seasons of the year are not equally favourable to malting; the brewers, whose attention is particularly directed towards the malting of their corn, for the preparation of beer, prefer the month of March to any other. The grain malted during that month is always of a better quality.

Malted corn would not keep in the state of humidity in which it is found on the malt-floor, nor could it be reduced into meal for the purpose of being mashed; it is then necessary to dry it; and this operation is executed as follows:—

DRYING OF THE MALT.

The corn having sufficiently germinated is taken to the malt-kiln, where it is spread in lays of from two to four decimetres thickness; then fire is made under it with combustibles, making no smoke, because, without this precaution, the malt might contract a smoky taste and transmit it to the spirit.

In the brewing of beer, various sorts of malt are made use of, which only differ one from another by the temperature they have been submitted to on the kiln; but we will recommend to dry corn, destined for distillation, at a temperature as near approaching 50° or 55° as possible, it is the most favourable to the quality of the malt. In fact, this temperature, which is also that of the mashing, occasions, in the wet grain, a new formation of sugar, in small quantity, it is true; but this influence of the kiln is not without producing good effects on the subsequent operations, and the temperature of 50° or 55° is attended with the greatest success.

The combustibles most generally used for the purpose of drying malt are coke, or distilled coals: such is that furnished by the establishments of hydrogen gas, or even that proceeding from the distilleries. Next to that comes the vegetable coal, which, if it can be procured at a low price, is very suitable for the purpose. After this comes the coal known by the trade under the name of *ash-tree* coal. This species of combustible makes little or no smoke when burning, and exhales sulphureous vapours, which, if we are to add faith to the experience of practitioners, is not at all obnoxious to the quality of the malt.

The grain increases greatly in bulk by the operation of malting: this augmentation may be rated at about one eighth or ninth part; and their specific gravity decreases in proportion: I say specific, because the real loss sustained in weight, during the fermentation of the grain on the malt-floor, is not easily perceived; but as it occupies, after this operation, a greater space under the same weight, it is easily conceived that it does not weigh as much under the same bulk: so that one hectolitre of raw barley, weighing sixty kilogrammes, will fill, when malted, a measure of about one hectolitre and one-eighth part of one: one hectolitre of malt will then only weigh from fifty-three to fifty-four kilogrammes.

Section IV.

COMBINED APPLICATION OF THE OPERATIONS DESCRIBED IN THE TWO PRECEDING SECTIONS.

Now that we are acquainted with the process of malting and with that of mashing, as also with the effects of these operations, let us apply them properly.

Of all the kinds of corn, rye is almost the only one used for the purpose of distillation. Other corn might, it is true, equally be used; but, in an economical point of view, rye produces the most favourable results.

It might be used in the raw state, and might undergo the vinous fermentation, after having been suitably prepared and mashed; but experience has proved the necessity of adjoining to it a certain portion of malted barley.

To this effect a quantity of barley is malted, and then mixed to raw rye in the proportion of twenty kilogrammes of malted barley to eighty of rye; this mixture is submitted to the operations of grinding and mashing.

By this method rye produces more than by any other preparation. Its produce is greater thus than when used alone, even when malted.

Malted barley has the property of rendering rye more fermentable, and it is only in co-operating, by its materials, to the conversion of the fecula of the rye into sugar, during the mashing and even during the fermentation, that it produces this effect.

Distillers observe particularly the effect of malted barley on rye, in the act of distillation. I have consulted many practitioners on its mode of acting, and all have agreed in attributing to it the property of giving lightness to their lob or paste. In fact, they have ascertained that, in working with raw corn alone, the fermentation is not so good, and, when submitted to distillation, the heavy matter which is found in suspense in the liquid has a very great propensity to precipitate itself to the bottom of the still, and strongly to adhere to it: the least inconvenience attached to this accident is that of communicating a bad taste to the spirits, and it has happened that the bursting of the apparatus has been occasioned by it; so that it is necessary to prevent such accidents, and this result is obtained by mixing the raw grain with a portion of malt.

Practitioners explain thus the action of malt, by saying that it gives *lightness* to their paste, and prevents its falling to the bottom of their still.

This explanation, however incomplete it may appear, is, nevertheless, the expression of a positive fact. Indeed, so long as the fecula has not been converted into sugar, it forms, with the water, a kind of paste, which has very little fluidity, and which, if exposed to the fire, may easily stick and burn to the bottom of the still. What happens when malted barley is used with the raw grain? We have already said it: the barley, by its germination, has undergone a change which renders it more proper to saccharify the fecula. We have already indicated this fact, and we will produce unexceptionable proofs of it, when treating of the potato. Now, to saccharify fecula is to destroy the paste which gives viscosity to the liquid, and to supply the fermentation with proper aliments; which is effected, in the distillation of grain, by means of malted barley, and, by thus favouring the fermentation, a double advantage is obtained—that of having a liquid less heavy, and, of course, more easy to be distilled.

It often happens that distillers are in want of malt; then they are forced to distil their raw grain without it. To obviate a little the inconveniences attached to this way of working, they add, during the mashing, a quantity of chaff. They attribute to this chaff a property analogous to that of malt, that of giving lightness to their matter. I have ascertained that chaff has this property, if not of saccharifying fecula converted into paste, at least to fluidify it, and render it more attackable by the saccharifying agents. It is even probable that barley, besides gluten, contains another matter, which, like chaff, contributes, but more energetically, to the fluidification of fecula. This supposition is the more probable, because no other grain, even when malted, possesses, to the same extent, the property of saccharifying starch. For this reason it is always employed, in preference to any other grain, by brewers and distillers.

The proportion of chaff used is from three to four pounds per quintal of raw grain. Its effect is well known in practice, and many distillers add it to their grain, even when they use malt. Brewers, also, make use of chaff, because they have been convinced of its good effects by comparative experiments.

The rules which I have laid down before, for the perfect practice of mashing, may be followed without any restriction, whether the corn operated upon be raw or malted, or whether the mixture be composed of grain in those two states. It may have been remarked that mashing, such as I have described it, occasions the fermentable matter to be more or less heavy, according to the quantity of water used, and also according as it has been more or less perfectly executed. Even admitting all the fecula of the corn to have been dissolved during the mashing and fermentation, a certain quantity of husk would always be left in suspension in the liquid, and this quantity is rather large. From this method, results, that the distiller is obliged to commit matter to the still, which is very dense, and apt to burn, in spite of all precautions that might be taken to prevent this accident. This method is the only one used in France and in Belgium, notwithstanding the inconvenience attached to it. We are acquainted with another method, followed in England and in Germany, and by which the distillation of pastes, or lobs, is avoided; but, whether it necessitates more labour, or whether we are not acquainted with the means of practising it successfully, I am not aware of its introduction, in France, into any distillery. I think it necessary to describe the method followed in France, with the most perfect series of operations connected with it. By these means it will be possible to make comparative experiments on both methods, and to ascertain which of the two is attended with the most benefits.

FRENCH METHOD.

Supposing the quantity of corn made use of to be one hundred kilogrammes.

This grain being mixed in the proportion of eighty kilogrammes of rye to twenty of malt, is ground into coarse flour, then deposited, with two or three kilogrammes of chaff in a fermenting back, containing twelve hectolitres; the steeping is effected by pouring on the meal three hectolitres of water at about 35°; then it is mashed with four hectolitres of warm and cold water, mixed in such proportions as to give to the mass, after the brewing is over, a temperature of from 50° to 55°. The tub is covered up and left to itself for three or four hours. At this period it is filled six or eight inches from full with warm and cold water, mixed in such proportions as to give to the mixture a temperature of about 20°; one litre of good yeast is then added.

A few hours after, the fermentation commences and proceeds through its various stages in the space of thirty hours: then it is time to commit the liquid to the still.

If the operation has been well conducted, from forty-five to fifty litres of good spirits at 19° are obtained from the one hundred kilogrammes of grain.

Many distillers are far from producing as much, and there are even some who do not draw more than from thirty to thirty-five litres.

The exiguity of this produce may be the result of several causes; but one of the most influent is the proportion of water used, that is to say, that instead of using eleven hectolitres of water for every one hundred kilogrammes of grain, they only use six.

In a continuous work the spent-wash left in the still should be deposited in vats, or in cisterns constructed for the purpose: there the solid substances will fall to the bottom, and the liquid will remain uppermost. This liquid may be successfully used in the subsequent operations to dilute the grain after it has been mashed. In this practice is found the advantage of bringing again to fermentation a liquid containing some fermentable substances, which have escaped decomposition. This may be followed up, for several successive operations, that is to say, three, four, and even five; and the grain produces thus as much as sixty litres of spirit at 19°, per metrical quintal, produce very considerable, and which could not be obtained by any other means. The use of spent-wash is suspended, when, after several operations, it is become so sour, that instead of offering proper aliments to the fermentation, its acidity would be obnoxious to it.

If a smaller proportion of water was used, the same march could not be followed, at least, not to the same extent, because then the fermentation would require three or four days instead of thirty hours, and, by these means, cause the spent-wash to be very sour.

In this mode, in which the liquid submitted to distillation must necessarily be very heavy, no use can be made of improved apparatuses; and the condensing apparatus described in another part of this work is used in preference to any other.

In working with this apparatus care should be taken to stir the first charge submitted to the still, until it acquires a temperature approaching that of ebullition, because, without this precaution, the matter might stick and burn at the bottom of the still; this danger disappears when the mass is boiling, and, as in a continuous work the condenser causes the wash to arrive at all times boiling into the still, it will easily be conceived that it is sufficient to agitate the first charge.

It would, however, be very advantageous, in this mode of working, to obtain from the grain all the fermentable matter which it contains, and to obtain it in dissolution in water, so as to render the liquid to be submitted to distillation, free from husk or any other solid matter: by these means the trouble of agitating the first charge would be avoided; there would be no danger of having the wash burned, of having bad products, and the various improved apparatuses might be successfully used. No doubt, these effects might be obtained by adopting the following method:

ENGLISH METHOD.

(See also p. 142.)

This method consists in treating the corn in a double-bottomed tub, and to make extracts exactly in the same way as the brewers.

The grain, composed of malt and rye, being mixed and ground in the same way as for the mashing in the French way, ten kilogrammes of chaff are spread on the first bottom in a lay of two centimetres in thickness; two hundred kilogrammes of grain are thrown upon it.

Then four hundred kilogrammes or litres of water at 35° or 40° are introduced by a lateral conduit communicating with the empty space between the two bottoms, while the mixture is agitated for about five or ten minutes, then the matter is left to subside for about one quarter of an hour, or half an hour, so as to be well penetrated with water; this operation is exactly the same, and its object is the same as that of steeping, which precedes mashing in the method just described. The only difference existing is in the construction of the apparatus made use of.

Immediately after steeping, the matter is again agitated while eight hundred kilogrammes of hot water are let into the tub through the same conduit; this time the brewing should last about a quarter of an hour, at the end of which the liquid is to be left to itself for at least an hour. At this period the grain is drowned in the water, and a column of liquid tolerably clear covers it, a cock communicating with the space left between the two bottoms is then opened, and as the conical holes of the superior bottom form a species of filtering-machine, all the liquid is drained and let into the fermenting backs.

After this first extraction, six hundred kilogrammes more of boiling water are added, in the same way, the mass is again agitated for a quarter of an hour, and left to subside for one hour, the liquid is drained the same as before, to be submitted to fermentation. The grain on the double bottom has now been sufficiently deprived of all its fermentable substances, which the water has taken away in dissolution, in the state of liquid sugar.

This operation, which is a true mashing, well understood and well executed, proves, beyond doubt, the effect of mashing on the corn,—it proves that it is, as we have said, a true saccharification. When the liquid in the fermenting backs is fallen to a temperature of 20° or 30°, according to the capacity of the tub, yeast is added, and wash without sediment is thus obtained, which can be distilled in all kinds of apparatuses.

If the grain left on the double bottom was found not to be sufficiently exhausted, a third extraction might be resorted to.

The Germans follow the same method in the distillation of corn, with this difference, that they work with no other grain but what has been malted. Their way of working is then exactly similar to that of our brewers, who submit also all the corn they use to the process of malting.

To make the best of this method, the proportion of water should be increased, or at least the extracts should be lengthened out with cold water, so as to bring the quantity of water used to ten or twelve times the weight of the corn. Several advantages might be derived from such a proceeding. 1st. A more complete, more rapid, and less acetous fermentation might thus be obtained. 2d. The spent-wash, on leaving the still, might be appropriated to new extracts, and I have no doubt but what greater products would be the result.

I owe my information on the influence of the proportion of water employed in the distillation of corn to Mr. Cafler, an able and experienced distiller in the department of the North. The march I have described in the French method is that followed by this gentleman, for this process is not generally in use, but I have preferred giving that of Mr. Cafler, because I have seen it produce the most spirit.

Section V.

RICE.

We are acquainted in France with two qualities of rice very distinct one from the other. The best, and that for which there is the greatest demand, comes from Carolina, and is known by that name; the other comes from Piedmont, where it is grown to a great extent. I am not aware of rice being the object of distillation in any part of Europe; the cause of it is, I have no doubt, the great consumption of this vegetable, which in this part of the world is of such value as not to suffer its produce to enter into competition with that of the raisin and of corn, vegetables more generally grown.

The English, however, consume a great quantity of spirits of rice, to which they have given the name of arrac; but they receive this produce from the Indies, and from all the American colonies, where rice is found in such abundance as to constitute the only solid food of the labouring class. The negroes, in fact, receive this article from the agents of the East-India Company as wages for their labour.

We have but an imperfect idea of the process used, in India, to prepare rice for fermentation. We know, however, that it is submitted, to this effect, to the process of malting, and the knowledge we possess of the fermentable properties of vegetables will enable us to conceive the utility of this preparation. Rice, in fact, contains no sugar, and its composition, according to M. Braconnot's analysis, appears to be essentially farinaceous. This chemist has found the Carolina and Piedmont rice to contain from eighty-three to eighty-five per cent. of their weight of fecula, or starch.

I will not here repeat all that has been said by the various technologists who have written on the precautions to be taken in malting rice. The incomplete and similar notions which they have given us, on that subject, clearly prove that they all have copied one from the other. However, as the distillation of rice might, in many countries, and under various circumstances, attract the attention of manufacturers desirous of supplying trade with a spirit remarkable for its peculiar taste, I will indicate the means which, according to my experience, appear to be the most proper for this kind of fabrication.

To produce arrac from pure rice it would be necessary to malt the latter, and to this effect, submit it to all the operations connected with malting, that is to say, it should be steeped, malted, dried, and ground into flour. The only difference that would exist between this process and that of malting grain, would be, that rice would require much more time to be sufficiently steeped and malted. As for the rest of the operations they are exactly the same.

Rice being thus brought to the state of ground malt, may undergo a very good spirituous fermentation, whether it be mashed and fermented in the state of lob, or whether its farinaceous principles be extracted by means of the double-bottomed tub. The distiller might adopt either of those two methods, according as he wishes to distil either heavy matter or such as is exempt from sediment. As to the method of fermenting rice prepared by either of those two processes, it is absolutely the same as in the fermentation of corn. The mashing requires the same temperature, the quantity of water made use of has the same influence over the spirituous produce, the only difference between the fermentable properties of rice and those of other corn is in the impossibility of causing it to ferment by solely preparing it by mashing.

However, it might be sufficient only to malt a certain portion of the rice destined for distillation, and to mix it in the proportion of one-fourth or one-third of malted rice to three-fourths or two-thirds of unmalted; the fermentation would thus be equally complete.

There is another method of predisposing rice to fermentation, which I have always found to be successful: it is founded on the property which malted barley possesses of saccharifying the grain that is mashed with it.

Supposing that eighty kilogrammes of rice are to be worked; first they are reduced into fine and well divided flour. This is thrown into a tub of about twelve hectolitres, and there it is diluted in eighty kilogrammes of water, such in temperature as to cause the thermometer, after the mixture has been well agitated and brought to a uniform mass, to rise to 18° or 20°. This mixture is left to subside for about half an hour, while twenty kilogrammes of malt, ground into fine flour, are separately steeped and well diluted in an equal weight of water at 30°.

The mixture of rice having been left to itself during the time indicated above, the tub is uncovered, and boiling water is let into it until the mass becomes thicker, and has the consistence of a dense lob; all this while the mixture is agitated, until the thermometer has risen to from 70° to 72°. Then the mashing commences; it is effected by throwing into the tub the portion of malt, separately steeped. The mixture is then agitated in all directions, to render it homogenous and to establish a perfect contact between the malted barley and the rice. When this condition is evidently fulfilled, the tub is covered up again, and the wort is left to subside for three or four hours.

At this period a phenomenon worthy of remark takes place; the mixture has undergone a total change, and the tub, which a few hours before contained a compact and pasty matter, now presents a liquid completely fluid, slightly sweet and saccharine, and there is only a small sediment formed at the bottom, which is composed of the husks of the grain and of the rice, and also of a few lumps, from one or the other of these two vegetables, that have escaped decomposition.

It is now sufficient to lengthen the liquid out with cold water so as to bring it to 5° density, and to the temperature proper for fermentation. This proceeds well through all its stages, and gives a vinous liquor, which is distilled without difficulty, the sediment being so small and of so little strength, that it may be neglected without any prejudice.

This operation shows the utility of malt in the fermentation of corn, in all its light, and it is here evident that it possesses the property of converting the fecula, reduced into a paste by boiling water, into a kind of soluble matter, which has all the properties belonging to sugar.

This mode is then very practicable in the distillation of rice; it has the invaluable advantage of giving greater and better products, while it renders the wash perfectly fluid.

Section VI.

MAIZE.

Maize, according to the inquiries of Parmentier, is indigenous of America. "It was the wheat of this new hemisphere," says this eminent economist, "and it served the Indians not only for food, but it was used by them in the preparation of fermented liquors; the *chiaca*, so celebrated in those countries, was prepared with this grain, and spirits were produced from it by distillation."

This is all we know about the possibility of making fermented liquors with maize, and of producing spirits from it by distillation.

However, this kind of grain begins to be introduced into our agriculture with some success: trials have been made to mix it with wheat, for the purpose of baking, and the results have been favourable.

The composition of the maize appears to be analogous to that of rice; like the latter, this vegetable appears to be essentially farinaceous, and cannot be used for the purpose of baking, without being mixed to some other substance, because gluten is not connected with its composition.

Maize, according to my opinion, is not unworthy of the attention of distillers, and as it might be cultivated in many of our departments at very little expense, it might very well enter into competition with all sorts of corn.

It is easily conceived that, to distil maize alone it would be necessary to submit it the same as rice to all the operations connected with malting; as to the rest, the process would be the same. But I have no doubt but what the march we have indicated for predisposing rice for fermentation, by means of malted barley, might be successfully applied to maize. Every thing tends to show that the same phenomenon of the fluidification and saccharification of the fecula would take place, and that the same advantages attached to the distillation of rice would result from the distillation of maize. I have not made any experiment on that point, but I am not less convinced that this mode would be the most proper to produce spirits from this vegetable.

In consequence, I recommend it to the distillers who might be inclined to make some experiments on this kind of fabrication; every thing convinces me that a great quantity of spirits might be produced from it.

Section VII.

POTATOS.

We are acquainted with two methods of preparing potatos for fermentation, entirely distinct one from the other. The first is especially combined with the feeding of cattle, and, in this respect, is more generally in use in the country, where the utility of distilleries is appreciated. The other, the only object of which is to produce a spirit free from flavour, and which, in these latter times, was scarcely any where practised but at Paris, is, however, not entirely unknown in the country. The former has been described by Mr. M. de Dombasle, and the other has never been properly developed. This has been the cause, I have no doubt, of its being so little propagated in the country.

CHOICE OF POTATOS.

The quality of potatos used for distillation is not indifferent. We have already said that potatos only produce spirits in proportion to the quantity of fecula they contain, and as the fecula, together with the fibre and water united, constitutes this tubercle, it will be necessary to be guided, in the choice of them, by the principle that those that contain the most fecula are the best.

We will hereafter, when treating of the fabrication of fecula, produce the means of thus verifying the quality of potatos.

The potato prospers in sandy and dry soils; there it grows less watery and, of course, more farinaceous, which is not the case in damp and argillous grounds; its culture requires little attention; it is planted in March or April; a fortnight after it shoots out of the ground, and it is harvested in October. Upon an average, one hectare of potatos will produce four hundred and forty hectolitres, or thirty-five thousand kilogrammes, reckoning the hectolitre to weigh eighty kilogrammes; one-sixteenth part of this quantity, two thousand two hundred kilogrammes, is required for seed, so that the net produce is thirty-three thousand kilogrammes, or four hundred and thirteen hectolitres.

The farinaceous produce of the different kinds of potatos varies, as may well be conceived, from twelve to twenty-five per cent. of fecula of the total weight. The rest is water and a quantity of fibres, which varies from four to six per cent. of the weight of the tubercle, according to the species, but as the tissue of this fibre contains itself a certain quantity of fecula, it may be said that the poorest potatos contain at least fourteen or fifteen per cent. and the richest from twenty-seven to twenty-eight per cent. of fecula.

The richest species is then the most proper for distillation, for it will produce the greatest quantity of spirits, and it may easily be conceived that poor potatos will necessitate the same expenditure as those that are more productive.

The *parmentière* potato is used with success for the purpose of distillation, because it contains but a small quantity of husk, in comparison with the twenty per cent. of fecula which it contains, say from three to four per cent. which is not indifferent to future results, whatever be, besides, the method followed in preparing it. Besides this, it offers another advantage, that of containing only a small portion of the acid principle, by which some kinds of potatos are distinguished, and this quality has great influence on the spirituous produce, which, by these means, gains in sweetness.

These are fixed rules by which the distiller should be guided in the choice of potatos. Those that are the most farinaceous, when boiled, and the most agreeable to the palate, must always be preferred to any other.

The most favourable season for distilling potatos is from the month of October, when they are harvested, to the month of March, when they begin to germinate. The latter circumstance has great influence on their quality, causes their proportion of fecula to decrease, and renders their spirituous produce much less in quantity.

As the distillation of potatos more especially takes place in the winter and in the latter part of the year, the frost, which comes almost regularly at that time, might injure the quality of the potatos, if proper precaution was not taken to protect them against its influence. To this effect it is necessary to place them in warehouses where the thermometer never sinks to 0°. Cellars are very proper to fill this object, because they keep almost invariably, in winter as in summer, a temperature of 10°.

There are two methods of preparing potatos for fermentation; the object of both is to saccharify their fecula.

The first is by means of malted barley, and, although practised in town distilleries, is more generally followed in the country, because it is more intimately connected with the feeding of cattle, and is composed of three operations.

About the year 1770, potatos were first used for distillation, and the method then adopted consisted in submitting them to the action of boiling water, as it is still done in their preparation for food. To this effect stills of three or four hectolitres were used; but the difficulty of getting the potatos out of these vessels, and the expenses of fuel, soon caused it to be replaced by that of steaming them, which mode is much less expensive.

Various apparatuses have been invented for boiling potatos: the following is the most perfect.

Fig. 1, p. 364, represents this apparatus, erected on brickwork.

A is a copper still, provided with a cover B, strongly fastened to the neck of the still by means of iron nippers, similar to those made use of in the improved apparatus of Adam and Bérard, of which we will speak hereafter.

The cover B bears a curved tube C D, which carries off the steam; the extremity D of this tube is furnished with a collar, by which means it may be screwed to any other tube; this mode of fastening has been considered the most commodious. E F is a safety tube, which is also used in filling the still, and which plunges into the latter to about five centimetres from the bottom.

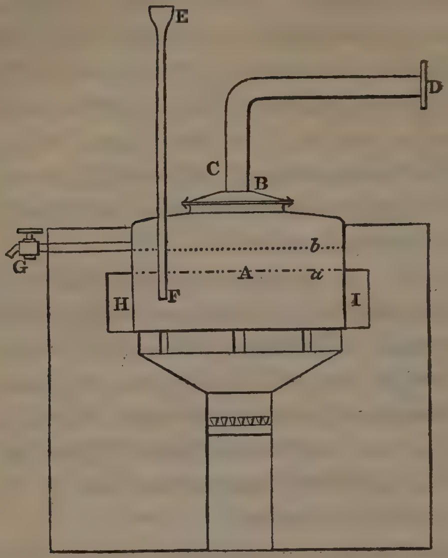
This tube is a safety tube, inasmuch as it would cause the water to run out by its orifice E, if the pressure in the still was too great, and it also shows, by giving passage to the steam, when the water should be renewed in the latter.

G is a cock fixing the level of the water in the still when charged. To this effect it is always open, in a continuous work, during the filling of the still. The function of this cock is two-fold; it gives access to the air, and thus prevents the dangers resulting from absorption. See what I have said on the subject of absorption, in speaking of the precautions to be taken in filling the still of the simple apparatus.

The still A is calculated to produce eighty-four kilogrammes of steam per hour, providing it be supplied with boiling water, for if this was to be brought to ebullition by the still itself, a much less quantity of steam would be formed. It contains two hundred and thirty litres up to the line *a*, and three hundred and six up to *b*, which is the full charge.

It would be easy to supply this still constantly with boiling water; this might be done by placing above it a small vessel filled with water, which might be brought to ebullition by means of the heat which escapes the first still; a great economy in combustibles might thus be obtained.

Fig. 1.



The tube D, adapted to another tube F, in fig. 2, conveys the steam produced by this still, into a tub, represented in the cut by figure 2, calculated to hold twelve hundred and eighty litres of matter, but as it is nesessary never to fill it entirely with raw potatos, because ebullition causes these to swell, it is only charged with eleven hectolitres.

Fig. 2.

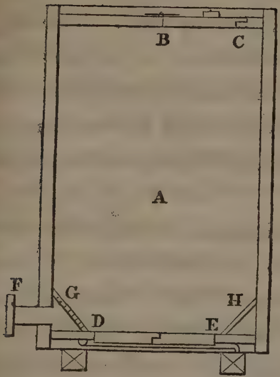


Fig. 3.

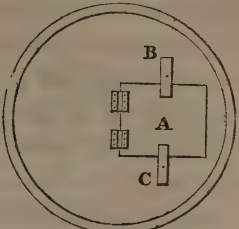
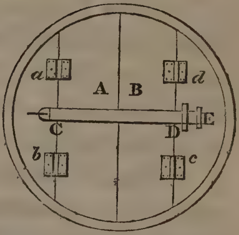


Fig. 4.



A is a cylindrical tub, made of strong oak, the interior of this tub is lined with copper or with lead, so as to render it sufficiently solid.

The potatos are introduced through a trap, B C, fixed in the head of the tub, and they are discharged through a double trap, D E, placed in the bottom.

Fig. 3 represents the head of this tub.

A is a trap hanging on two hinges, which can be shut and closely maintained to the head of the tub by means of two buttons, B and C.

Fig. 4 represents the bottom of the tub.

A and B form a double trap opening in the middle, and hanging on four hinges *a, b, c, d.* It is opened by removing an iron bar, C E, fastened by the end C to an iron cramp by means of a pink, which gives it sufficient play. This bar slips into E, where it is retained by means of a button D; and when it is unhooked and separated from E, it hangs by the extremity C, and causes the double trap to open, and thus to let the boiled potatos fall out.

The tube F, fig. 2, is destined to introduce the steam into the tub A; its internal orifice is protected by an inclined plane, C, full of holes. This keeps the potatos from stopping the tube F, and from thus being an obstacle to the free entrance of the steam; it is also useful, the same as the plane H, to prevent the boiled potatos from being left in the corners the tub. By means of this apparatus and of the boiler, we have just described, nine hundred kilogrammes of potatos may be boiled in one hour, this will require fourteen kilogrammes of coals.

It is necessary, as a matter of economy, to lute the various parts of this apparatus, through the joints of which steam might be lost. This is done by means of clay mixed with horse-dung or of any other lute.

The most convenient place that can be given to the tub is above the hopper of the reducing machine, of which we are about to speak.

REDUCTION OF POTATOS.

When the potatos have been suitably boiled, they occupy a greater space, and this dilatation causes their peel, which is not very strong, to be broken; this renders them proper to be submitted to the action of the reducing machine, of which we will give a description.

This machine is represented by fig. 5 and 6.

Fig. 5 is a lateral elevation of it, shewing the side of the machine where the two wheels work in each other.

Fig. 2 is a plan of the machine seen from above without the hopper.

The same letters represent the same pieces in both figures.

A A A A is a strong frame built in oak.

B and C are two cylinders made of wood or of stone, but better of cast metal. Those two cylinders are of equal diameters; they are a few millimetres one from the other, and their function is to break the potatos by their unequal rotatory motion. This unequal rotation is obtained by means of two wheels of different diameters, *a* and *b*.

D is a moveable hopper supported by the frame in *c d*. It is made for the purpose of receiving the potatos to submit them to the action of the cylinders.

E F are two handles fixed on the axis of the cylinder C. They serve to work the machine.

G H is a scraper. It hangs on *e*, and the weight g, which acts upon the lever G *e*, presses the extremity H of the scraper against the cylinder B. This scraper serves to separate from the cylinder the broken potatos that might stick to it.

h, *i*, *j*, *k*, are moveable boards held by two grooves; these close the interior part of the machine, and form one side of a chest, which receives the broken potatos. These are let out on the side I, through a mobile shutter.

Fig. 5.

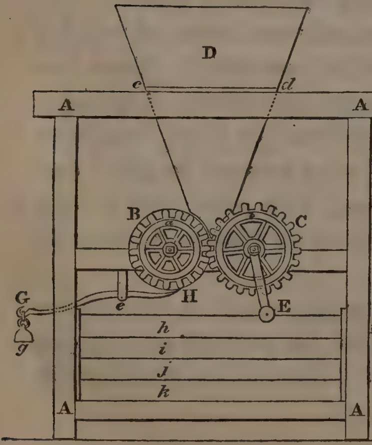
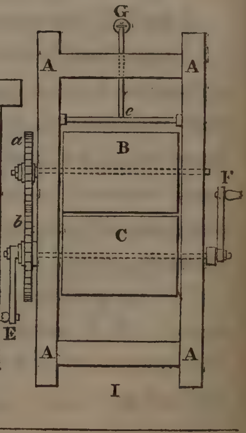


Fig. 6.



The construction of this machine is extremely simple, not at all expensive and very little subject to repairs. I have fixed two handles to it, although one man might work it; but it would be better, in an uninterrupted work, to employ two men. One thousand kilogrammes of potatos may thus be reduced, in the course of ten or twelve hours; a greater product might be obtained by applying more force to it, and by making use of such wheels as would accelerate the rotation of the cylinders.

MASHING OF POTATOS.

The potatos having been reduced into paste are mashed with malted barley, in the same manner as described in the French method, that is to say, at a temperature of 50° to 55°.

Suppose a quantity of potatos are to be worked sufficient to produce twelve hectolitres of fermentable matter.

A tub, containing at least thirteen hectolitres, is made use of; the pulp of four hundred kilogrammes or five and one-third hectolitres of potatos are deposited into it, in the state of paste. About twenty-five kilogrammes of malted barley are added to this paste, together with a quantity of warm and cold water suitable to establish in the tub a temperature of from 30° to 35°, which is the heat requisite for the steeping of grain;

the mixture is strongly agitated, and left to subside for one quarter of an hour or half an hour. Then, while the mass is again stirred, boiling water is introduced until the thermometer has risen to 50° or 55°. The paste is now left to macerate for two or three hours; then a mixture of cold and warm water is added, in such proportion as to form twelve hectolitres of liquid at 20° or 25°. One litre of good yeast is then added, and the fermentation is established in a few hours.

It is worthy of remark, that, in this case, as also in the mashing of corn, the saccharifying action of the barley, signalized in the mashing of rice, is very little perceived. After the last mashing there is only a small quantity of sweet liquid swimming above the paste, so that in this state the fecula of the potatos has not been entirely converted into sugar. The reason is, that the fecula has not been sufficiently decomposed in potatos boiled by steam. To liquify and convert this fecula into sugar by means of malted barley, it is necessary to place it in immediate contact with the latter; the husks and the granulary and crystalline state in which the fecula is found in potatos boiled by steam, fulfil but imperfectly the condition necessary for the complete saccharification, which we have observed in the mashing of rice. This saccharification is completed in the fermentation, at a much lower temperature it is true, but not in so short a period. In fact, this conversion of fecula into sugar takes place as long as the fermentation lasts. To this process, simple in itself, are attached all the inconveniences inherent to the distillation of pastes. Agriculture, which is deeply interested in this kind of industry, has long since been in want of means to remove this imperfection, without too hasty innovations, and without affecting the simplicity and economy belonging to this method. The innovations I am about to propose have been submitted this year to the Agricultural Society, in the memorial which it has deigned to crown.

Important Modifications to the preceding Method of saccharifying Potatos by means of malted Barley.

These modifications may be executed in two ways: the first consists in isolating the fecula of the potato, to work it with malted barley; by the other the separation of the fecula is avoided, by directly operating on potatos simply divided by the rasp. As the fabrication of fecula will be useful to us not only in this, but in the second method, we will give a description of it, such as is practised in Paris for the purpose of distillation. I establish this restriction for the preparation of fecula, because it does not require, for distillation, the same care and management as when made for domestic purposes.

PREPARATION OF FECULA FOR DISTILLATION.

This preparation is composed of two operations: 1st. The rasping of the potatos. 2d. The separation of their fecula. Even sometimes, when the distiller does not choose to make his own fecula, he buys it from the feculist, who submits it to a third operation—that of draining.

We will successively speak upon those various operations.

Rasping.—The object of this operation is to tear the tissue of the vegetable, the cells of which contain the fecula which it produces, so that the better the vegetable is divided the better the rasping will have been executed, and, by these means, a greater quantity of fecula will be obtained. To this effect the potatos are submitted to the action of Burette's rasp, already described, and which, although it is far from being brought to perfection, appears to be the best made use of. Immediately after this operation the following commences:—

Separation of the Fecula.—To this effect, a large sieve of horse-hair, two feet in diameter and one foot in depth, is made use of. It is placed above a tub, on two cross pieces, and then filled with a quantity of pulp, equal to about two-thirds of its contents. This pulp is strongly malaxated between the hands, while a continuous stream of water, proportionate to the dimension of the sieve, is running in the latter. For a sieve of two feet in diameter and one in depth, the water may be introduced through a pipe of four or five millimetres in diameter. This water, by means of the movement which the pulp undergoes, penetrates the latter, and runs through the sieve into the tub, carrying the fecula away in a state of dissolution. This operation is continued until the water running through the sieve is clear, and not impregnated with fecula. Then the pulp is thrown aside for the purpose of feeding cattle, and is replaced by other, which is in the same manner deprived of its fecula.

From two thousand five hundred kilogrammes of good potatos five hundred kilogrammes of fecula, supposed to be dry, are obtained, or seven hundred and fifty kilogrammes of drained fecula, which then bears the name of raw fecula. The latter is to the former :: 3 : 2, so that three kilogrammes of raw fecula will give two kilogrammes of dry; thirteen hectolitres of pulp, or husks of potato, are moreover obtained, which contain about the same quantity of water as the raw potatos, that is, three-fourths of their weight, so that those thirteen hectolitres of pulp retain about nine hundred and seventy-five litres of water.

This pulp may be given to cattle; but it is by far not so good as that resulting from the distillation of pastes, which is well boiled and nourishing. It might be possible to obviate these inconveniences, in a distillery, by boiling the pulp with the hot spent-wash that is left in the still after distillation.

I have seen a more suitable disposition of the sieve than that which I have just indicated, and I think it necessary to notice it here. It consists in filling, at once, with water, the tub destined to receive the fecula; the sieve is suspended, on the upper part of the tub, with ropes, so as to be immersed in the water; a to and fro movement is given to it, by which means the pulp is freed from its fecula, which falls to the bottom of the tub. After this operation, the pulp is entirely exhausted by merely sprinkling a small quantity of water over it. This is but a modified disposition, which I think useful, and which does not in the least alter the mode of working. The fecula thus separated from the pulp sinks after an hour's rest to the bottom of the tub, when the depth of the tub does not exceed sixty or seventy centimetres, and forms a thick and solid sediment; holes made in the sides of the tub are then opened, that nearest to the top of the sediment included. The water runs off, and the fecula is left in the bottom. If the latter is to be made in solid pieces, it is drained in the following way :—

Draining.—To this effect an apparatus, called Drainer, is made use of: it is a wooden chest, open on one side, widening in the shape of a cone towards the opening. The sides and bottom of this chest are filled with an infinity of small holes, the exterior part is covered with a cloth of strong linen, or hemp. This drainer must be placed above the tub destined to receive the water that is to be drained; the fecula is then placed into the drainer, and, in the course of twenty-four hours, it loses all the superfluous water which it retained, and is found, it is true, in a state of humidity, but it is sufficiently solid to be transported without being made into paste.

When the fecula is thought sufficiently drained; the drainer is turned over on a table used to this effect, and there it is broken into pieces.

This operation is only necessary, as we have already observed, when the fabrication of fecula is not connected with that of spirits. This has been done at Paris, for instance, where many distillers buy their fecula from the starch-makers.

From a metrical quintal of good potatos eighteen to twenty per cent. of dry fecula is obtained. No more can be reckoned upon, for the operation of rasping is not perfect enough to produce the numerical result indicated in the chemical analysis.

FIRST MODIFICATION.

For a tub of twelve hectolitres, intended to contain only eleven hectolitres of matter, from eighty to eighty-five kilogrammes of dry fecula, or from one hundred and twenty to one hundred and twenty-five kilogrammes of raw fecula, or all the fecula resulting from four hundred kilogrammes, or five and one-third hectolitres of good potatos are made use of. This quantity is deposited in the tub with a portion of cold water, so as to form a tolerably clear paste, that is to say, with about twice its weight of water: in this instance it will be about two hundred litres. But great care should be taken to stir this mixture, because, without this precaution, the fecula, which is much heavier than water, would promptly precipitate itself to the bottom of the tub, and there form a hard sediment, which is with great difficulty brought to a state of suspension. This state of suspension is necessary for a subsequent part of the operation.

Every thing being thus disposed, and the necessary agitation having been given to the mass, from five to six hundred litres of boiling water are gradually let into the tub: and, before the whole of this hot water is in the latter, the mixture has already become thick, and has been converted into what is commonly called paste. This paste has, at first, a milky appearance, but, when the six hundred litres of water are thoroughly mixed with it, the heat produced by them soon causes it to be remarkably clear and transparent.

At this period the fecula is ready for being mashed, which is done by adding to it from twenty to twenty-five kilogrammes of malted barley, separately steeped. In this instance the action of the malt is as conspicuous as in the mashing of rice, and in the space of ten minutes, time requisite to mix the malt with the paste, the latter is completely fluidified. It is then left to subside for three or four hours, as in the mashing of corn, and after this time, the liquid has acquired a very sweet taste. It is now sufficient to dilute it with water, so as to have eleven hectolitres of matter ready for fermentation.

The advantage of this mode of working over that generally followed in the country is easily perceived. The liquid, after having fermented, is found to be very fluid, and the sediment, which is composed of the husks of the corn and of a little portion of leaven, is very small.

It may not be useless to remark that, in this case the malted barley should be ground into fine flour, and not merely broken, because its action on the fecula is thus more energetic, more perfect, and more rapid.

The wash obtained by these means and made with the given proportions of water and matter, marks about five areometrical degrees. One litre of good yeast is sufficient to bring it to fermentation.

SECOND MODIFICATION.

The special object of this second modification is to avoid the labour occasioned by the isolation of the fecula from the pulp. This is the way of practising it with advantage and economy. A double-bottomed tub, of about eight hectolitres, is made use of. From ten to twelve kilogrammes of chaff are spread on the first bottom, and the pulp as it is produced from the raw potato, is placed upon it; say that obtained from four hundred kilogrammes or five and one-third hectolitres of potatos. There it is drained for half an hour or a quarter of an hour, and thus a portion of water, naturally connected with its composition, is extracted without trouble. The latter is drawn off by means of the cock communicating with the space between the two bottoms.

The mixture is then stirred, as in the English method, while from four to five hundred kilogrammes or litres of boiling water are gradually let in: the whole mass is now thickened; this change is caused by the conversion of the fecula into paste. This mixture is then mashed with twenty-five kilogrammes of malt, previously steeped, and the liquid is left to subside for three or four hours. It is then drained and let into the fermenting-back, which contains eleven hectolitres. What is left is well drained for about a quarter of an hour, then two hectolitres of boiling water are again let in. This mixture is agitated, drained, and taken with the rest to the fermenting-back. This lowers the temperature of the liquid. To cool and exhaust the paste completely, the whole surface of the sediment on the bottom of the tub is sprinkled with two or three hectolitres of cold water, which are drained and let into the fermenting-back with the other extracts.

In operating thus, the husks left on the double bottom are sufficiently exhausted; they only retain, after one hour's draining, three-fourths of their weight in liquid, slightly charged with fermentable matter, which might be neglected in a well conducted distillery, where the feeding of cattle is an object.

But, at all events, if the loss of liquid was thought of any moment, the pulp might be entirely exhausted by means of a cylindrical press. Full half of the weight of the drained pulp might be obtained in liquid, but a simple draining is sufficient, and the practice of pressing the residue should only be resorted to in cases where a smaller quantity of water has been used for mashing than I have recommended.

In this way of working, the fermentable matter being necessarily left to itself for a certain space of time, and often requiring to be taken from one tub to the other, is tolerably well cooled, and gains, towards the close of the operation, a suitable temperature for fermentation, and marks about 5° density.

There are, then, three ways of saccharifying the fecula of potatos by means of malted barley. It requires very little reflection to see that the first mode is evidently inferior to the other two. In fact, under whatever light it be considered, whether as a matter of economy in labour and combustibles, or with respect to the quality or quantity of the spirituous produce, it will never bear comparison to the other two. It is necessary that the potatos should be boiled by steam, and this is indispensable. This steam is to be produced on purpose and occasions expenses in fuel. In the other two ways, no combustibles are wanted to convert the fecula into paste proper to be mashed, and by working as we have advised for the mashing of grain, that is, to boil the matter intended for fermentation, whether it be isolated fecula or pulp, with the spent-wash left after distillation. In one case, the potatos must be broken between two cylinders; in the two other cases, it is sufficient to rasp them, and this operation is not expensive, considering the great quantity that can be rasped by two men. In the first case, the matter submitted to the still is heavy and pasty, it requires more combustibles to be brought to ebullition, and more expense is occasioned, through the necessity of continually agitating it, and without speaking of the bursting of the apparatus, which it might cause, the spirit produced from it is always more or less charged with empyreuma. In the other cases, the matter is perfectly fluid, does not require any precaution to be taken in distilling it, and gives a better flavoured spirit.

The superiority belongs, then, evidently to the two last modifications I have proposed, and of those two I have not the least hesitation in declaring the latter to be the best: one hundred kilogrammes of potatos may thus produce from fifty to fifty-five litres of spirit at 19°.

This spirit, as all potato spirit, has a small taste of the fruit, which is not pleasant, but of which it may be freed by rectification.

SECOND METHOD.

Process made use of to convert Fecula into Starch by means of Sulphuric Acid.

The discovery of this process is owing to Kirchoff, and was made towards the end of 1811, at St. Petersburgh.

Two kilogrammes of starch are diluted in eight kilogrammes of water, sharpened with forty grammes of sulphuric acid, at 66°, and kept in a state of ebullition for thirty-six hours, in a leaden or silver basin: the mass is agitated during the first hour, to keep it from sticking to the bottom of the vessel; after this time it becomes very fluid, and only requires to be stirred, at intervals: as the water evaporates, it should be replaced; when the liquid has sufficiently boiled, chalk is added; the mass is left to cool and settle, and then acquires a saccharine and agreeable taste: being clarified and evaporated till it gains the consistence of syrup, it has a very intense taste of sugar, and may be converted, by cooling, into concrete sugar.

In this experiment, Kirchoff used starch made for domestic purposes, and as soon as it was published, all the chemists at home and abroad were anxious to verify it and bring it to perfection: Mr. Vogel, at Paris; Messrs. Itner and Keller, at Friburgh; Mr. Lampadius, at Friburgh, in Saxony; and many other enlightened chemists, published, in 1812, the results of their experiments. The latter substituted the fecula of potatos to the starch made use of by Kirchoff. He altered also the process of the latter in many respects; instead of boiling the mixture of fecula and acid, in a basin made of lead or silver, or tinned copper, which are not without inconveniences, he recommended the use of a wooden vessel, in which the liquid might be boiled by steam. By this disposition he then created an art, which has since been so usefully applied in France to the distillation of potatos.

In fact, till that period, no other mode of distilling potatos was known, except that of boiling them, and afterwards mashing them with malted barley. To this method was attached the great inconvenience attending the distillation of pastes. The hope of liberating themselves of this yoke, and of producing spirits of a better quality, stimulated the activity of manufacturers and men of science to such a point, that the art of saccharifying fecula, by means of sulphuric acid, has now become a manufacturing operation, simple in itself and easily practised.

The tub of this apparatus contains about twenty hectolitres; three hundred kilogrammes of fecula may be worked in it. The operation is conducted as follows: six hundred litres of water are let into the tub; the water is brought by the steam to a temperature of about 80°, during that time the three hundred kilogrammes of fecula are diluted in another tub, made for the purpose, with six hundred litres of water, mixed with six kilogrammes of sulphuric acid, at 66°. This diluted fecula is then gradually poured into the saccharifying tub, through the trap-door fixed on its upper part. The lob finds thus in the tub water sufficiently hot to convert the fecula into paste, which is soon liquefied by the sulphuric acid with which it is mixed. To conduct this operation well and to avoid difficulties, it is necessary not to throw the fecula into the tub at once. In this case, for instance, it may be introduced at three different times and in three equal quantities. The first portion is introduced when the water in the tub is 80°, and care should be taken thoroughly to blend the mixture; the boiling is continued, the paste becomes liquid by means of its contact with the sulphuric acid, and the temperature, which the addition of the lob had caused to lower, soon rises to 80°. At this period, the second portion of diluted fecula is added, the mixture is stirred, and the temperature lowers again. The formation of paste causes the mass to thicken, and it is again liquefied as the temperature increases. When the latter has risen to about 75°, the last portion of fecula is thrown into the tub and stirred. The same phenomena are again observed. Caloric continues to be introduced until the temperature of the mass has risen to 80°.

At this period the trap-door is closely shut, and sometimes even luted, and the liquid is left to itself for about six hours. During this time the saccharification of the fecula takes place, and it requires to be favoured not only by the presence of sulphuric acid, but by a temperature constantly maintained at 80°. In the beginning of this art the steam was introduced into the tub during these six hours, in order to keep the temperature at the boiling point, but it has been well recognized that this ebullition is useless, and that to obtain good results it is sufficient to keep up the temperature, as we have recommended. We may easily conceive the advantages belonging to this mode of working, by which is saved all the fuel necessary to maintain the still in ebullition six hours longer than is required.

It has been observed that I have recommended six kilogrammes of sulphuric acid to be used, for three hundred kilogrammes of fecula; this makes in acid two per cent. of the weight of the fecula. This proportion might be increased, as Saussure has observed, without prejudice to the success of the operation. In fact, this chemist has recognized that a greater dose of acid always renders the saccharification more perfect and more prompt. The proportion of two per cent. is, however, sufficient, providing it be left to macerate for six hours. There is a way of recognizing when the saccharification is complete, and that no particles have escaped this transformation: that is, to try it with the tincture of iodine. This body has the property of turning all feculas to blue or to violet, whether they are in a state of solidity or suspension in the water, or dissolved into paste. By these means we may recognize the different periods of the saccharification of the fecula in this operation. In fact, immediately after the brewing is over, take a small quantity of tincture of iodine and pour it on the wash, it will instantly turn it to blue wherever it is in contact with it. When treated a few hours after, in the same way, its colour will not alter so much, and when the mixture has been left to subside for six hours, during which a temperature of 80° has been kept up, the colour will not alter at all. This type announces that the matter has been completely saccharified, and that it is time to proceed to other operations.

The trap-door is then opened, and the sulphuric acid is neutralized. This acid, in fact, is not at all decomposed during this work, and is found in the liquid in the same state exactly as when put into it. To neutralize this acid, it is necessary to place it into contact with a body with which it combines and forms an insoluble substance. This result is obtained with lime, or, what is better, carbonate of lime, which may everywhere be found.

If lime be used, great precaution should be taken to have the precise quantity necessary, because too small or too large a dose would be equally prejudicial to fermentation. This difficulty of determining the agent of neutralization, is avoided by using carbonate of lime (limestone), and this substance may, without danger, be used to excess. To neutralize six kilogrammes of acid, ten kilogrammes of carbonate of lime, or chalk, reduced into fine powder, are requisite. They are diluted, in this state, in two or three times their weight of water, and this mixture is gradually poured into the tub, while the liquid is strongly agitated. The moment this carbonate comes into contact with the acid, an effervescence takes place, which is caused by the carbonic acid gas bursting on the surface of the liquid. Chalk should be added until the effervescence has ceased. This point of saturation is obtained with about ten kilogrammes of chalk for about six kilogrammes of sulphuric acid, and if this is not sufficient more should be added. The colour of the violet and of the sunflower is turned into red by the presence of acids; so that by plunging either of them into the wash, we may easily know whether there is any acid left or not. This mode is hardly ever followed in distilleries, because no fears are entertained from the use of too great a quantity of chalk. Besides, they ascertain easily, by inspection, the term of saturation, by means of the property which the carbonate possesses of producing effervescence, when neutralizing sulphuric acid.

I will not say anything more about this operation which is founded on the theory of chemical affinities; let it be sufficient for me to say that the carbonate of lime is decomposed by the sulphuric acid; its acid basis is set free, in the state of gas, while the lime forms a new combination with the sulphuric acid, which is sulphate of lime or plaster. This substance is insoluble in water, and precipitates itself to the bottom of the tub, in the solid state, with the excess of the carbonate, which is also insoluble.

The neutralization of the acid having been effected, the liquid is again left to subside, for about half an hour, or an hour; in this instance, it is useless to preserve the heat, as is done for the purpose of converting the fecula into sugar. The only object, in this case, is to allow the sulphate of lime to precipitate itself to the bottom of the tub; this precipitation may be perfect in one hour's time.

Two cocks are fixed in the tub, one is placed on a level with the bottom, and the other three or four centimetres above it. The latter is opened to ascertain whether the precipitation is complete: thus, it is necessary that the liquid which comes out of it should be clear, and not contain any solid matter in suspension. All the liquid in the tub is then drawn off, and taken to the fermenting backs.

The sediment left on the bottom of the saccharifying tub is drawn off through the other cock, and is drained through a strong hempen cloth. The liquid which runs off by filtration is added to the other.

Let us see now what quantity of liquid matter we have obtained from three hundred kilogrammes of fecula:—

First, we have filled the tub with water........................	600 litres
We have diluted the fecula with a similar quantity	600 ,,
Reckoning the specific gravity of the fecula to be equal to fifteen hundred grammes per litre, three hundred will give in bulk	200 ,,
The whole of this mixture, in being	

brought to ebullition, has condensed a certain quantity of steam, which, according to rules, hereafter explained, is equivalent to...... 200 litres

Total.............. 1600 litres

We will thus have sixteen hundred litres of matter composed in weight as follows:—

Water	1400 kilogrammes
Fecula	300 „
Total	1700 kilogrammes

These one thousand six hundred litres will have a specific gravity equal to $\frac{17000}{1600}$, say one thousand and sixty-three grammes per litre equivalent to 9° Beaumé.

Many distillers bring their worts to fermentation at this density of 9°, and to this effect, it remains there until the temperature of 20° or 25° is established; then leaven is put to it.

I have no doubt but what it would be more advantageous, on more than one account, to dilute this liquid much more, for fermentation, and to bring it to 5° or 6° by the mere addition of cold water. The trouble of letting the liquid remain to be cooled for fermentation might be avoided, and the cold water, made use of to dilute it, would establish the temperature required at once. By this method, all the advantages signalized, in the application of it to the mashing of corn, would be obtained: the fermentation would be sooner at an end, more alcohol would be produced, less acid would be formed, and the spent-wash, on leaving the still, might be appropriated to subsequent operations.

At Paris, from twenty to twenty-five litres of spirit at 19° are commonly drawn from fifty kilogrammes of fecula saccharified by means of sulphuric acid. Every thing induces me to believe that this produce might be increased by working as I have recommended, that is by diluting the fermentable matter down to 5° or 6° density, and by making use of the spent-wash in the subsequent fermentations.

We may at least be convinced that the quantity of spirits drawn from a given weight of fecula, is far from approaching to that indicated by theory. In fact, supposing one hundred kilogrammes of fecula to have been treated with sulphuric acid, and fifty litres of spirits, at 19°, to have been drawn from it, let us see what weight of pure alcohol those fifty litres contain. Spirits at 19° weigh nine hundred and thirty-five grammes per litre; fifty litres will thus weigh 50×935, or 46,750 grammes, and, by applying to this case the rules, by which the composition in weight and in measure of spirituous liquors is calculated, we shall find those fifty litres of spirits composed as follows:

Alcohol	12,375	grammes.
Water	34,375	,,
	46,750	grammes.

One hundred kilogrammes or one hundred thousand grammes of fecula have thus produced twelve thousand three hundred and seventy-five grammes of alcohol.

We will admit that, in practice, one hundred thousand grammes of fecula give but one hundred thousand grammes of sugar, and we know that sugar, decomposed by fermentation, gives almost half of its weight in carbonic acid gas, and the other half in pure alcohol: now were we to obtain the mathematical perfection, we would draw fifty thousand grammes of pure alcohol from that quantity. Let us now compare this result to that obtained in practice, and we shall see that we do not from a given quantity produce more than one-fourth of the quantity indicated by theory.

Every thing tends thus to convince us that we have much to do yet to bring the art of transforming fecula into alcohol to perfection.

CHAP. III.

On some auxiliary Agents.

Water often acts an important part in fermentation; we will turn our attention to it, as also to the various leavens made use of to actuate or determine the latter.

Section I.

(See page 83).

WATER.

Among the great number of vegetables used for the purpose of fermentation, some have their saccharine matter mixed with a quantity of water, sufficient to establish a perfect and prompt fermentation; others to obtain this perfection, require the addition of a greater or smaller quantity of water; others even, and they belong to our second class, have little or no water connected with their composition, and without it no fermentation can take place.

For a long while, erroneous principles have been professed on the quality of water proper for a good fermentation; I was the first, I believe, who refuted them, in an article inserted, in 1822, in the first number of the *Annales de Chimie et de Physique.*

From the observations signalized in these remarks, we may conclude that water has, in fermentation, the greatest influence on the spirituous produce.

Every kind of water, provided it be potable and wholesome, may be used for fermentation; but between those kinds as are most generally in use, we may establish the following distinctions:—

Distilled water is the least beneficial; next comes rain-water, and then river-water.

These three sorts of water, which have often been signalized as the best for fermentation, for this very reason, that their lightness and their pureness render them preferable in any other art, are less fit for distillation than either spring-water or well-water.

The latter, in fact, often contain matter in dissolution that may be very serviceable to fermentation.

Those of Paris contain plaster and lime-stone in dissolution.

Those that have nothing but lime-stone in dissolution are, for this reason, preferable for fermentation.

Nothing is so easily recognized as the latter sort of water: when boiled it deposits tolerably thick couches of stones, which are formed at the expense of the calcareous salt in dissolution in it. To recognize whether this sediment is lime stone, take a small part of it in a glass and pour vinegar on it, if an effervesence takes place, it is a sign that the substance contains carbonate of lime or lime-stone, which is the same thing; when it is completely dissolved in the vinegar with effervescence, so as to form a clear liquid without sediment, it is a sign that it is pure carbonate of lime, and the water that produces it may be considered as the most proper for fermentation: we will explain the cause of it when treating on the subject of fermentation.

The influence which the quality of water may exercise on fermentation has not been studied yet sufficiently to establish precise and invariable rules for its choice. It might happen that the water of certain wells or springs is less favourable to the success of fermentation than rain or well water. This might be caused by the presence of substances, which, instead of being, like lime-stone, favourable to it, would, on the contrary, be very obnoxious; such would, for instance, be animal substances, which would cause the wine to undergo the acetous and putrid fermentations. At Paris, the water, drawn from beneath the calcareous veins, contains a large quantity of animal matter, which renders these waters little fit for fermentation. We will, hereafter, see the various phenomena produced by these waters. In all instances they must be rejected by distillers.

Comparative experiments, executed with care, are the best criterion by which the distiller should be guided in chusing between the various kinds of water which are at his disposition, only it is necessary he should be well convinced that the quality of water is far from being indifferent.

Section II.

LEAVEN.

A number of fermentable vegetables have a peculiar matter connected with their composition, known by the name of leaven or ferment. Its presence determines the spirituous fermentation in liquids, which, without it, could only undergo the acetous or putrid fermentation.

This substance is thus necessary for the production of spirits, and when the liquids intended for fermentation do not contain it, the want of it should be supplied by a leaven, which can either be gathered or composed by art.

Hence the distinction established between natural and artificial leavens; the first are those connected with the composition of vegetables, and which give to the latter the property of fermenting alone; the others are those that result from the fermentation of vegetables, and also those that are composed of various substances.

About the first we will say but little; they are retained in a state of dissolution, in various proportions, by the juice of fermentable vegetables. The raisin contains a great quantity of it, and in a suitable proportion for the perfect fermentation of the sugar which it contains. The juice of the cane, of beet-roots, of cherries, pears, apples, and that of all fruits that are sweet and sourish, contain more or less of it; during their fermentation this leaven swims on the surface of the liquid, in the state of scum, and may thus be gathered, to be added to those vegetables that do not contain it.

Leaven thus collected does not always possess the same qualities, it varies according to the nature of the vegetable by which it has been produced, and the most energetic artificial leaven known is barm or yeast, which results from the fermentation of beer, and is generally preferred to any other. Other is only made use of in places where the absence of breweries disables distillers from using it.

Next to the leaven produced by the fermentation of beer, comes that resulting from the fermentation of grain; that of potatos fermented with one-fifth of their weight of malted barley is very weak and not at all energetic.

A phenomenon worthy of remark, and the knowledge of which should never be lost sight of by the distiller, is the influence of the temperature of boiling water on the properties of leaven.

The juice of the grape, for instance, which contains the leaven necessary to be decomposed, ferments after a few hours, when placed under favourable conditions; this would not be the case if, before it is set to work, the temperature was brought to the boiling point, even if it was afterwards brought back, by cooling, to the temperature proper for fermentation. In this instance the leaven loses, momentally, its exciting properties, which it only recovers after a lapse of time. However it does not appear that its exciting properties have been in any way altered by its being exposed to a heat of 80°, they are only suspended, and after a few days become as energetic as before.

Yeast becomes easily putrid, and to obtain good results it is necessary to preserve it. The more liquid it is, and the higher the temperature to which it is exposed, the sooner it is corrupt, so that it keeps worse in summer than in winter. In summer it may be kept in a good state for about a fortnight, provided it be deposited in cellars or other places where the temperature is constantly maintained at 10°. In winter-time it may be kept for many months, when the temperature of the atmosphere is constantly under 10°. When frozen it may be good, but if it is thawed, or if it rises to a temperature even below 10°, it soon becomes corrupt.

To preserve it well for a long time, it must be separated, as much as possible, from the water which it retains, and to this effect it is drained, then it is put into bags, made of strong linen, and submitted to the energetic but gradual action of a press; it is thus made into a hard paste, which causes it to keep longer and renders it more fit to be taken from one place to another.

Dry yeast is sold in Paris, but this yeast has lost, during the operation of drying, a part of the properties which it possesses in the liquid state.

Thus it is necessary to use fresh yeast as much as possible, as a leaven for fermentation, and to use it in the state it comes from the brewers. When yeast is good, the following proportions may be taken for basis in using it:—

The quantity of yeast to be put to a fermenting-back should be equal to the tenth or twelfth part, in measure, of the spirits, at 19°, which is to be produced by distillation. Thus, supposing that a tub will produce fifty litres of spirit at that strength, it will be necessary to use four or five litres of yeast; this quantity is necessary for matter that contains no natural leaven, such as the wash of potatos and of molasses, but for corn this quantity may be reduced to half.

To ascertain the quality of yeast, it is tried before it is committed to the tub. To this effect about the twentieth part of the liquid contained in the fermenting-tub is drawn off, and the leaven intended to set it to work is diluted with it. The vessel in which this is done is then covered, and, if the leaven is good, in about a quarter of an hour a very active fermentation is established. In this instance the liquid used for the purpose of trying the yeast is thrown into the fermenting-tub, the mixture is stirred, and the operation will not fail to be successful. But if the tumultuous effects of the leaven were retarded in the tub used to try it, the quality of the yeast must be judged according to the time its exciting movement is kept back. In this case more should be added to the small vessel, until an active and effectual fermentation is produced.

This is the best way of determining at once the exciting power of the yeast and of fixing the approximate quantity necessary to obtain good results.

We recommend this mode to distillers. As much yeast should always be used as is necessary for the perfect decomposition of the vegetable; this will have great influence on the spirituous produce. On the other side, the price of yeast, which is sometimes very high, and the bad taste the latter communicates to the liquid, when used to excess, requires the most exact dose possible to be made use of.

The difficulty of procuring fresh yeast in some countries, and the heavy price at which it is sold at times, have caused it to be replaced by artificial leavens, of which the following are the most efficacious :—

BAKERS' PASTE.

This kind of leaven is to be found any where, and can, besides, easily be made.

In fact, it is only necessary to operate like the bakers, that is to set aside a quantity of paste proportionate to the quantity of leaven that is to be made, and leave it to sour. At the end of from twenty-four to forty-eight hours, this paste, exposed to a heat of from 20° to 25°, which is generally the temperature of bake-houses, is sufficiently sour for their purpose, but not for distillation ; it would be well to let it sour for about five or six days, it acquires thus more exciting properties.

Leaven made in this way may be kept for a month, at a temperature of 10°, without being corrupted ; to this effect it is sufficient to keep it in vessels and to cover the surface in contact with the air with a small lay of common salt.

This leaven, however, is far from being so effectual as yeast ; and, although it be in the state of a thick paste, it is necessary to use a quantity double to the latter to obtain only equivalent results.

Moreover, it is remarkably inferior to yeast, which results from a sourness inherent in its composition; this sourness is caused by an acid, and as all acids have the property of producing acetous fermentations, they are, for this very reason, obnoxious to the spirituous fermentation.

OTHER LEAVEN.

Flour of rye, ground tolerably fine, is diluted in the brute state, the bran not having been separated, in cold water, so as to form a thick paste. Molasses are added to it in the proportion of one-fourth of the weight of the flour, then warm water is gradually added, and the whole is well stirred until it gains the consistence of a light paste and a temperature of 20° or 25°. A small portion of yeast, or bakers' paste, is now diluted with this mixture, the vessel is covered up and kept in a place where the temperature is about 20°. After one hour the fermentation should be established; if this should not be the case, a fresh quantity of yeast must be added. If the fermentation proceeds well, this leaven swells much and should be made use of as soon as it is arrived to the highest point of fermentation and before it becomes sour. It is generally fit to be used twelve hours after it has been made. This leaven is much preferable to the sour paste, although not possessing the same exciting properties. The flour of rye might be successfully replaced by that of wheat, and the molasses by honey. Moreover this leaven is not attended with the inconvenience of giving a bad taste to the produce of the fermentation when used to excess.

In this instance the consequences resulting from too great a dose of leaven are less to be feared, for the substances composing it are not lost for the spirituous produce, as they are transformed into spirits during the fermentation; whilst, on the other side, if too small a portion was made use of, the decomposition of the vegetable would be proportionably hindered.

I know of another leaven composed of sugar and eggs, but I have not sufficiently examined its effects, to give the exact composition of it, or to recommend it to be used.

PART II.

On Fermentation.

EVERY intestine movement which takes place in organical bodies, and which causes their nature to undergo a change, is designed by the generic name of fermentation. We are acquainted with three kinds of fermentation, very distinct from one another, by the products to which each of them gives birth, and by the nature of the materials submitted to their action.

The first is the vinous or spirituous fermentation; the second is the acetous; and the third the putrid fermentation. These three fermentations form three distinct periods in the decomposition of the vegetable substances, which the distiller may use. To these three periods it would be proper to add a fourth, which has been called saccharine fermentation. Be the exactness of this denomination as it may, it is not less true that the fact which it expresses is in existence. We have described it, in our First Part, by the name of saccharification, when we have proved that no farinaceous vegetables could pass to the vinous fermentation, without previously undergoing a movement which converts their fecula into sugar. So that when this fecula is operated upon, there will be four periods of decomposition: the saccharine, vinous, acetous, and putrid fermentations. These four kinds of decomposition may proceed simultaneously, and, in fact, this will always be the case, whenever it is not prevented by proper precautions. All four may be appropriated to different arts. Indeed, it may often be advantageous to convert fecula into sugar, to supply trade with it; the decomposition will not go further, in this case. If wine is to be made, the vinous fermentation is to take place, and saccharification could not be dispensed with, as no alcohol can be produced without sugar. The acetous fermentation acts but upon alcohol; thus, if vinegar is to be made from fecula, this is the result of the acetous fermentation turned to advantage, and this cannot be done without having previously caused it to undergo the saccharine and vinous fermentations. If the vinegar were left to itself, under favourable circumstances, it would pass to the putrid fermentation, and would thus only be useful as an agent of reproduction. All vegetables are not proper for the preparation of sugar, of alcohol, and of vinegar; but all of them may undergo the putrid fermentation, to be used as manure for land.

The object of the vinous fermentation, which is the most important here, is to transform into spirits all bodies susceptible of this decomposition, and to effect this with the greatest economy and perfection possible.

In the practice of the art of wine-making, two kinds of vinous fermentation are distinguished, or, to explain myself more properly, the fermentation is divided into two periods—the *tumultuous* fermentation, that which the wort undergoes in the tub, and the *imperceptible* fermentation, that which it undergoes immediately after it is barrelled; the results of these two fermentations are the same, their object, which is to produce alcohol, is the same, and the phenomena by which they are characterized only differ by their degree of intensity.

In the tumultuous fermentation, the internal movement of the liquid is violent, and, as the quantity of alcohol formed is always proportionate to the intensity of this movement, in this case there will always be a great quantity of spirits produced. The term of this fermentation is determined by the sinking of the head of the *must*; at this period the tumultuous fermentation is over, and the wine is barrelled; but, in this state, although the wine contains already the greatest quantity of alcohol it is capable of yielding, the whole of its fermentable substances have not been decomposed, and it retains yet a quantity sufficient to be of consequence, in many instances, to the value of the wine, and to finish the decomposition in favour of the alcohol. It is by the aid of the imperceptible fermentation that this result is obtained. To this effect the wine is kept in barrels for a lapse of time, which varies according to the density of the must by which it has been produced.

The object of this imperceptible fermentation being to develope in the wine all the alcohol it is capable of acquiring is always useful, whether the wine be made to be drank immediately, to be kept, or to be committed to the still: alcohol, in fact, is the most remarkable preservative agent of wine. Its presence, in the latter, in sufficient quantity, renders it fit to support long voyages in barrels. Hence the inferiority of some of our wines, which, like the red wines of Champagne, can scarcely ever be transported to a great distance.

On the other side, if wines, intended for distillation, undergo this fermentation, their value is increased by the quantity of alcohol they have gained by it. This fact is well known to vinedressers and distillers, who turn it to advantage, to fix the venal worth of the wine.

In countries, like the south of France, where great quantities of wine are submitted to distillation, the mode of fermenting differs very little, whatever be the destination of those wines. The wines intended for distillation, that do not begin to work immediately after the tumultuous fermentation, are barrelled as the rest, and undergo thus an imperceptible fermentation, more or less protracted and perfect, according as the distiller or the dealer is in want of them.

In distilleries where other vegetables are worked, such as grain, potatos, or molasses, it is always necessary to accelerate the fermentation, for various reasons which we will hereafter expose, so that it is not only necessary to avoid the imperceptible fermentation, but the success of the operation requires even the tumultuous fermentation to be restrained; it should be rendered perfect in the shortest time possible, and these conditions should be fulfilled without prejudice to the spirituous produce.

The art which these conditions concern has, consequently, been obliged to find the means of fulfilling them. We are now in possession of them; practice has consolidated their utility, and the theory of the laws of fermentation explains clearly their influence. These rules, impracticable in wine-making, are very useful in distillation, and, if they were generally known, appreciated, and adopted, would establish a different process for the fermentation of wine intended for distillation, and particularly for those wines which the want of barrels causes to be distilled on leaving the fermenting-tub.

Be it as it may with respect to the rational application of these means to the wines of the raisin, nevertheless they are attended with great advantages in all manufactories where the making and distilling of wine proceeds simultaneously: they are an application of the laws presiding over the formation of alcohol, and we will explain them hereafter, when treating on the subject of those laws.

CHAP. I.

Conditions of Fermentation.

The spirituous fermentation cannot take place without the combined concurrence of the following conditions:—

1st. the presence of a saccharine, or an equivalent body.
2d. .... of water.
3d. .... of caloric.
4th. .... of leaven.
5th. .... of air.

The union of these five agents is indispensable to the formation of alcohol; each of them acts a more or less important part; and, on their use and combination, well understood, depends the possibility and the success of the vinous fermentation.

Suppress one of these agents and there will be no formation of alcohol; combine them in various proportions, and the fermentation will vary according as they are more or less favourable to it; it may even happen that the alcohol will be formed and spontaneously changed into another body; this will be the case in the acetous fermentation. Let water or caloric be suppressed, no fermentation of any kind will take place, and the sugar will be left in the same state.

Section I.

ON SUGAR, OR EQUIVALENTS TO IT.

Without sugar, no vinous fermentation, and, consequently, no alcohol: it is the only material element at the expense of which alcohol is formed. All the other elements made use of in fermentation are only the agents and vehicles of the decomposition of the sugar.

Sugar, such as is meant here, is supposed to be dry, and brought to a solid state. Several kinds of sugar are in existence, all of which are distinguished by their physical and chemical properties, such as specific gravity, appearance, and taste.

The most remarkable of all is that which is brought by crystallization to the solid state, for domestic and other purposes: it is that of the sugar-cane. It is only pure when it has undergone the operation of refining: then it is white, crystallized, and inodorous; its specific gravity is equal to one thousand six hundred and six grammes per cubic decimeter, and its taste is sweeter than that of any other sugar.

The juice of the grape and the fecula of potatos, saccharified by means of sulphuric acid, produce, by the aid of suitable operations, a kind of sugar which is solid, but as its saccharine taste is very weak, as it cannot be crystallized, and can only be brought to a powdery state, it is very distinct from the latter.

A great number of vegetable extracts also furnish a kind of sugar, more or less approaching to the two kinds we have just described, and although several distinguished chemists do not admit of any other variations in solid sugars, I am not of their opinion, and I believe that the genus sugar is the head of a numerous family.

There is another kind of sugars, very distinct from these two; the variegations in their taste are infinite, according to the vegetables by which they are produced; they can neither be crystallized nor rendered concrete, and they are scarcely ever made use of in any other but the fluid state, that is, in dissolution in water. The only way of bringing them to the solid state is to evaporate them first till they gain the consistence of syrup, and afterwards to dry them at a mild and sufficiently protracted heat. They are true extracts, and are thus found in a solid and transparent mass, like gum. Their taste is more or less saccharine, and their colour is almost generally turned to a dark brown, which is caused by the heat made use of to dry them.

Notwithstanding the operation of saccharification, effected in corn and potato distilleries, under the name of mashing, this operation, as it is generally executed, is far from converting the fecula of the vegetables made use of completely into sugar, and matter is fermented, which is composed of sugar and fecula; the saccharification proceeds thus simultaneously with the vinous fermentation. The assertion which I make here is true in all cases where matter is fermented in the state of lob; it is not the case where this inconvenience is prevented by the means I have indicated in my First Part. It is evident that, when a portion of undecomposed fecula is introduced, this fecula represents then an equivalent to sugar, as it is to be converted into sugar during the vinous fermentation; and the production of alcohol must, in this case, be proportionate to the quantity of fecula set to work, and not to the quantity of sugar. Thus, in this instance, the fecula is a true equivalent of sugar, and we may estimate it as such in our calculations.

Sugar, when transformed into alcohol, loses nearly half of its weight in gas; and we have already shewn by what means to compute the quantity of alcohol, at any standard, that will be produced from a fermenting liquid. To this effect, it is sufficient to weigh the liquid before it is set to work, by means of an areometer graduated in specific gravities, and to calculate the weight of the sugar dissolved in this liquid; the half of the weight of this sugar will represent the weight of pure alcohol which ought to be produced by fermentation, supposing the latter to have been perfect, and no losses having been sustained.

For instance, let us take twenty hectolitres of must at 10° Beaumé, or one thousand and seventy-three grammes per litre; one litre of this must is composed in weight:

Of sugar..............	194$\frac{2}{3}$	grammes.
Of water..............	878$\frac{1}{3}$	do.
Given specific gravity	1073	

The twenty hectolitres will thus contain three hundred and eighty-nine kilogrammes, three hundred and thirty-two grammes, which should produce, by distillation, after a complete fermentation, one hundred and ninety-four kilogrammes, six hundred and sixty-six grammes of pure alcohol, at seven hundred and ninety-two grammes per litre, say two hundred and forty-six litres.

Thus, if this alcohol is drawn at 19°, seven hundred and eighty-seven litres will be obtained; at 22°, or nine hundred and fourteen grammes, five hundred and ninety-five litres will be produced; and at 33°, or eight hundred and forty-two grammes, three hundred and twenty-four litres will be drawn from this quantity.

If we consider that the density of the must, which we have taken for basis in our calculations, and which is only 10°, is far from being equal to the density of the must in Languedoc, which renders from one-sixth to one-eighth of its volume in alcohol at three-sixths, this must weighing as much as 16°; if, on the other hand, we consider that the three hundred and twenty-four litres, at 33°, which are to be produced by two thousand litres, at 10°, which is about equal to one-seventh of the whole bulk, we will easily recognize that, in practice, we are far from drawing from the must all the alcohol which theory indicates.

It is true that, in the musts of the raisin, sugar is not the only matter that concurs to their density, tartar and other substances often make up a great part of this weight. If to these facts, which complicate the calculations of valuation, which we have just given, are added all those inherent to fermentation, such as the formation of acids, and the various causes of unavoidable losses, it will easily be conceived that the estimation of the quantity of alcohol, which is to be produced by a given fermenting liquid, can only be approximate. Thus reducing even the quantity of alcohol to be drawn from two thousand litres of must, at 10°, to two hundred and eighty litres at 33°, we shall see that, in practice, so considerable a produce is never obtained. In fact, two thousand litres of must, at 10°, fermented and distilled, are far from giving two hundred and eighty litres at 33°.

The must of raisin appears, however, to be the most favourable of all fruits to the production of alcohol, that is, to the perfect decomposition of its sugar, for when wine has been well worked, when it has undergone a good tumultuous fermentation, and an imperceptible one sufficiently protracted, experience proves that all its fermentable matter has been decomposed, and I am not aware of any other vegetable giving a similar result.

The mode I have just indicated for ascertaining the productive faculty of *musts*, is only applicable to matter which is perfectly fluid, and which, retaining fermentable substances in dissolution, may be weighed by means of the areometer.

But for pasty matter, in which case this instrument is of no use, other means are to be resorted to for submitting it to the same valuation. Such will be the case in the distillation of potatos boiled by steam, in the distillation of corn, and all farinaceous vegetables, which have not previously been converted into soluble matter by saccharification.

For instance, if potatos are worked, the quantity of fecula contained in each sort made use of, should be estimated by analysis, which is easily practised. The quantity of tubercles made use of is known, say four hundred kilogrammes; supposing these potatos to yield twenty-five per cent. of their weight in fecula, say one hundred kilogrammes, this quantity may be considered as one hundred kilogrammes of sugar, which, like the latter, will lose by fermentation half of its weight in carbonic acid gas, to give birth to fifty kilogrammes of alcohol. Thus four hundred kilogrammes of potatos will not have rendered the theoretical maximum of alcohol they are capable of producing, as long as they do not give fifty kilogrammes of spirits at seven hundred and ninety-two grammes, say sixty-three litres, or their equivalents, that is to say, two hundred and one litres at 19°, one hundred and fifty-two litres at 22°, or eighty-three at 33°. This result is far beyond that obtained in practice; for experience proves that no more than fifty litres, at 19°, are drawn from four hundred kilogrammes of potatos.

It will be the same with corn. For instance, one hundred kilogrammes of rye, which, according to Einhof's analysis, contains about fifty per cent. of its weight in fecula, will only give twenty-five kilogrammes or thirty-two litres of alcohol, which will give one hundred and two litres at 19°. In this case, practice has come nearer to perfection, for sixty-four litres at this strength have been drawn from an equal quantity of grain. It is, however, clear that this kind of industry may be brought to greater perfection.

Section II.

ON WATER.

Water is one of the most remarkable agents made use of by nature to develope or decompose bodies; its action, which is always subservient to that of heat, varies according to the state of the body to which it is applied. When under the influence of life, vegetables and animals find in water an aliment indispensable to their existence and their nutrition; when deprived of this influence, they then find in water a cause of their destruction. In fact, without water animals could not exist, plants could not vegetate, seeds could not grow. On this principle is founded the preservation of corn, of sugar, of feculas, and of a great number of other vegetables.

Water is thus an indispensable agent of decomposition of every kind, and its presence in the vinous fermentation is not only rigorously necessary, but on the proportion in which it is found in it, depends the more or less expeditious, the more or less perfect transformation of the vegetable into alcohol.

To hasten or check fermentation, all other influential causes being the same, it will be sufficient to lessen or to increase the proportion of water. It must be increased by adding a fresh quantity of water to the liquid, and lessened by evaporating the latter, or by adding dry sugar or a syrupy dissolution to it. In one case as in the other the areometer will be a sure guide.

A large proportion of water accelerates the tumultuous fermentation considerably, it fulfils the object of the imperceptible fermentation, and renders the transformation of sugar into alcohol more complete. Although this principle presents a real advantage in its application, yet an unlimited extension should not be given to it, five or six areometrical degrees are the most calculated to be beneficial in distillation. By these means, together with the use of spent-wash, sixty-five litres of spirits at 19° may be produced from a metrical quintal of grain.

As to the most suitable quality of water for fermentation, we have already given our opinion on that subject. Water, according to its nature, may exercise a remarkable influence on the spirituous produce.

The waters that are the most prejudicial to the vinous fermentation, are those that are charged with organical substances. Such are those that are drawn from beneath the calcareous veins in different quarters of Paris. These have a great propensity to turn to the putrid fermentation. Mr. Clement has told us, in one of his public lessons at the *Conservatoire*, that he had often met with difficulties in fermenting with those waters. He assures us of having found nitrous acid in the worts proceeding from the fecula of potatos prepared for distillation, by means of sulphuric acid. There is no doubt but what the formation of this acid in the fermenting liquids, did proceed from the organical bodies in dissolution in the water.

Mr. Barré, an old distiller of fecula at Paris, has noticed to me a more extraordinary phenomenon, which he has at divers times observed in his fermentations of fecula: it is the disengagement of an inflammable gas. This is a very singular anomaly which our chemical theory cannot explain satisfactorily. Mr. Barré has remarked that each time this gas was produced, the fermentations were unfavourable, and the spirituous produce exiguous.

It is probable that the cause of this phenomenon is to be ascribed to the organical substances which develope a putrid fermentation in the liquid; in this hypothesis that inflammable gas might possibly be hydrogen, this gas being one of the products of the putrid fermentation.

Section III.

ON CALORIC.

Heat, as well as water, acts an important part in the vegetation, and the decomposition of bodies; its presence is always necessary to the life as well as to the destruction of organical bodies; without it, there is no life in animals; without it, vegetables can neither shoot nor be developed; without it, neither of them can be decomposed.

A vegetable or animal body will not be decomposed if it is only submitted to one of these two decomposing agents, water and heat. A vegetable body perfectly dry and warm, and another in a damp state at the temperature 0°, will keep equally well.

Heat acts an important part in the vinous fermentation, and water gives us the power of either accelerating or checking its progress; in fact, the lower the temperature of a fermenting liquid, the less tumultuous and energetic the fermentation will be. This principle, however, should not be extended so far for heat as it has been for water. The space of the thermometrical scale, which is favourable to the various decompositions which bodies may undergo, is between the tenth and the fiftieth degree; but the most proper heat for the vinous fermentation is between 10° and 30°; under 10° it cannot be established, above 30° the acetous fermentation acts at the expense of the alcohol, and there is besides loss of another quantity of alcohol caused by evaporation. So that when I say that the fermentation may be accelerated or checked by heat, I only mean the temperature of from 10° to 30°. The more the temperature of a fermenting liquid will approach 10°, the weaker and the slower the fermentation will be, and, on the contrary, the nearer 30°, the more active and tumultuous.

The degree of temperature to be given to liquids submitted to fermentation, must be fixed according to their bulk. The following scale may be taken for basis:—

To a tub of	5 hectolitres, give from..	25° to 28°
,,	10	20° to 25°
,,	20	15° to 20°
,,	30, 50, 100, and above..	12° to 15°

It is seen, by this scale, that the temperature is increased according as the quantity of liquid operated upon is small. This rule is founded on the principle, that heat is better retained by a large than by a small mass, and if to a small tub were given the temperature necessary to complete the fermentation of a large one, in a given time, the result would be, that the little tub would lose the temperature requisite for a rapid fermentation; instead of being at an end in two days it might require at least eight.

The heat given to the liquid for fermentation is not the only one that acts during this decomposition; the fermentation itself produces heat, and that in relative proportions to its intensity. The intensity of the fermentation is the exact expression of the rapid decomposition of the sugar, or of the rapid formation of alcohol; so that these three expressions mean absolutely one and the same thing. This heat which the liquid acquires during the act of fermentation, the same as that which has been given to it, is better retained in a large than in a small tub. This disengagement of heat, which increases at an equal rate with the intensity of the internal movement of the tub, has caused the fermentation to be divided into three very distinct periods.

First period.—The first period is the moment the fermentation is established. The heat developed by this movement is sufficient to replace that which the liquid loses by cooling, so that the temperature of the liquid rests stationary; but as the fermentation advances the heat increases, and the second period commences.

Second period.—This period begins when the fermentation is the most active, and of course when the temperature of the tub is the highest. This increase of heat varies according to the capacity of the tub, and to the richness of the *must*, not that in the latter case the fermentation is the most prompt, but because a dense liquid loses its heat not so easily as another which is in a state of fluidity more approaching to water. The rising varies from one degree to ten degrees. As the fermentation subsides, the heat decreases and falls down to its pristine point. This is the third period.

Third period.—The fermentation is completed here, the head of the liquid sinks by degrees, the heat of the must makes equilibrium with that of the place in which it is worked, and finally takes its temperature.

The cooling of the tubs is dependent on the calorific state of the place in which they are; it is material to the success of fermentation to vary their temperature according to that of the fermenting-house. The colder it is, the greater should be the heat that is given to the liquid. However, it would be dangerous to establish a fermenting-tub in a place where the temperature would not be constantly above 10°; and the smaller the tub, the greater the danger. With respect to temperatures above 30°, we have no occasion to fear them in this country, so that it is useless to mention their obnoxious influence on fermentation.

In a great number of distilleries the fermenting-cellars are open on all sides, which exposes them to the variations of the temperature of the winter and the summer.

This circumstance has so much influence on the spirituous produce, if the temperature of the tubs is not varied accordingly, that I have seen many distillers suspend their work in summer because they could not produce so much spirit as in winter. This fact can easily be explained, and the erroneous conduct of these distillers will be conceived, when it is known that they always operate in the same way in all seasons. They have no other guide to give a proper temperature to their tubs, than an invariable mixture of cold and hot water, they neglect the use of the thermometer, which some of them do not even know. From this results, that if the constant temperature they give to their fermentable liquid, is suitable in winter, it must become pernicious in summer, as it is then too high, and, from this must inevitably result a great loss of alcohol, by evaporation, and by transformation of a quantity of it into acid. This is so far true that I have been myself in one of those distilleries, when worts were fermenting with such activity, that a tub of six hectolitres was submitted to so rapid a movement as if it had been under the influence of a large fire. The whole cellar was filled with alcoholic vapours, as if the tub had undergone the process of distillation. Is it then astonishing that wine thus fermented, renders less by distillation than that which has been suitably worked?

It would be better, as I have seen it practised by enlightened distillers, to dispose the fermenting-backs in closed cellars, in which is maintained a constant temperature, which, if possible, should be, in winter as in summer, a few degrees under that of the fermenting liquid. If, for instance, tubs of ten hectolitres are made use of, and that a temperature of 20° is given to them, that of the cellar should be 17° or 18°; so that in summer, this heat may be established without fire, as it is very near the temperature of the atmosphere; only there should be no possibility of the cellar being warmed by the furnaces of the still-house, because this contrivance, which would be economical in winter, would be pernicious in summer. By this mode, and with those dispositions, it will easily be conceived that with tubs of ten hectolitres, which may be worked at 20°, the same mixture of hot and cold water may be used in every season, without any material prejudice to the spirituous produce, for, as the temperature of the cellar may be the same during the whole year, that of the tubs may also be the same. This result could not be obtained with tubs of from twenty to one hundred hectolitres and upwards; for this reason I recommend the use of tubs of ten hectolitres, which are besides the most convenient and the most manageable. If tubs of twenty or thirty hectolitres were made use of, a close cellar would always be advantageous during the winter, because they would thus be secured against the influence of the heavy colds; but in summer, to obtain similar results, it would be necessary to vary the temperature at which they are set to work, and to lower it according as that of the atmosphere rises. Let us take an example: if we had a tub of forty hectolitres to set to work, and that we were at liberty to regulate the temperature of the cellar, we would give to the tub, according to the rules we have established, 14°, and to the cellar about 12°; but if, as it is the case in summer, we were not enabled to fix the temperature of the fermenting-house, and the temperature were to rise to 16°, it would then be necessary, as much as possible, to set the liquid to work at 12°. But it must be said here that the more advantageous large tubs are in winter, by their faculty of better retaining heat, the more obnoxious they are, for this very reason, in summer.

All the rules which I have just laid down, as to the heat necessary for fermentation, are the same for wines of the grape as for those of corn, which we have often taken for example, with this difference, that the wines of the grape are only fermented at the time of the vintage, in autumn, when the temperature of the vineyards is generally favourable to their fermentation. The must of the raisin takes then evidently the temperature of the atmosphere, and the greater the quantity harvested in the heat of the sun, the warmer its temperature will be.

From what I have said on the influence of heat on fermentation, may be concluded that this influence is always combined with that of water. One and the other offer this analogy of effects, that they can accelerate or retard fermentation, and that, by varying their proportions, similar results may be obtained.

In fact, if a liquid of 10° density and 15° temperature does not ferment well, if the dose of leaven be sufficient, it must be accelerated by one of these two means: either to add water at the same temperature to it, or to warm the mass by any practicable means. Of these two ways the first is preferable, because, while it actuates the fermentation, it also causes the matter to be better decomposed, in a shorter space of time, whilst the other, as it actuates the fermentation, causes a relative proportion of alcohol to be lost, which is so much the greater, as the heat added to the liquid is higher in temperature: this mode is not easily practicable, and I have only signalized it here, to establish a parallel.

If, on the other hand, the fermentation proceeds too rapidly, it can be checked, 1st. By taking water away from the liquid, which is impracticable, but to which an equivalent is substituted, that is, to add dry sugar, or a syrupy dissolution to it. 2d. By cooling it by any means.

This analogy between the properties of caloric and those of water in the fermentation is a knowledge far from being useless to the distiller, who may meet every day with an opportunity of applying them successfully.

Section IV.

ON ATMOSPHERICAL AIR.

Mr. Gay Lussac has verified, by the most exact experiments, the influence of air on fermentation, and we do not entertain, in these days, the least doubt on that point. Atmospherical air, through the portion of vital air, or oxigen, which it contains, is not only the aliment of life, but also the vehicle of the decomposition of bodies. In fact, Mr. Appert's mode, the most effectual known at this time, to preserve vegetables and flesh-meat sound and entire, is founded on this principle, and consists in keeping the body which is to be preserved, from coming into contact with the free oxigen of the air. Mr. Gay Lussac, to verify the action of air on the vinous fermentation, crushed raisins in a vessel plunged in an atmosphere of carbonic acid gas. All other precautions had been taken to prevent the must of the raisin from coming into contact with the air. This must was placed under circumstances favourable to fermentation; it contained water, leaven, and the whole substance of the raisin, and a suitable heat was given to it. It remained thus a long while without giving the least sign of fermentation, but, the moment it came into contact with the air, a tumultuous fermentation was spontaneously produced, which proved evidently the part which air acts in the vinous fermentation.

It acts as leaven to this fermentation, and, the moment the internal movement has been given to the tub, its presence is not only useless, but it might even be pernicious, if its contact with the fermenting mass was in any ways facilitated.

The first and indispensable influence of air, as an agent to determine fermentation, is rigorously useful; but the knowledge of this fact, in which theory is more interested than practice, might cause the distiller to take many useless and, sometimes, even pernicious precautions, if I did not explain myself more on that subject.

I have seen, in fact, some distillers to whom this principle was well known, and who, in consequence of it, would have taken care never to cover their fermenting-tubs, from fear of intercepting the communication with the air. This precaution, if not obnoxious as it facilitates the cooling of the liquid, is at least entirely useless, and this will never be necessary under any circumstances. The contact of the air is indispensable, it is true, but any liquid submitted to fermentation always retains air in dissolution; and, if the must of the raisin, when it is yet enveloped by the skins, does not contain any, it gains a large quantity of it in dissolution during the pressing. It will always be sufficient to pour the liquid from one tub to another through the air, to charge it with this air, if it is not already saturated with it. Rain, spring, fountain, and river waters contain air, and communicate it to the liquids fermented with them. The quantity of atmospherical air necessary to determine the fermentation of ever so large a tub is so small, that all the tubs that are set to work take the air which they want, not from the couch which weighs upon them, but from the air they have in dissolution. It is thus a mistaken application of these principles to keep the tubs uncovered until the fermentation is established. Moreover, if the liquid to be fermented did not contain, in dissolution, the air necessary for the determination of its fermentation, the space, which is left for the head of the fermenting liquid always contains a quantity of air more than sufficient to determine the movement. Thus, without any danger of infringing on the indispensable condition of the presence of air in fermentation, the fermenting-tubs may be closely covered up, so as to prevent, from the beginning of the operation, the inconvenience resulting from an immediate contact of the atmosphere with the liquid in fermentation.

The moment the fermentation has been established, the presence of air in the liquid becomes obnoxious to the spirituous produce. It is air, in fact, that favours the fermentation of acids: these acids, as we well know, are always created at the expense of the alcohol, and are themselves the most energetic leavens for the acetous fermentation. The way to prevent it in wine is to keep the air from having access to it. Acid once formed in wine leavens the whole mass, which is soon converted into vinegar; on this principle is established the fabrication of vinegar at Orleans, and in any other place where this kind of industry is carried on. In fact, to favour the formation of this acid, the wine is often decanted from one vessel into another, in order to establish a perfect contact with the air, and attain with greater rapidity the object in view.

The most dangerous period for the formation of acids in the fermentation of raisins is towards the end of the operation, because, as long as no alcohol is formed in the must, no danger is to be apprehended from acids, and, the moment the fermentation is established, the carbonic acid gas, which is in abundance discharged from the tub, being heavier than air, fills, for this reason, the empty space of the tub, and preserves it thus from an immediate contact with the atmospherical air. During the fermentation the tubs should not be uncovered more than can be helped, for a movement would thus be occasioned which would displace the couch interposed between the air and the liquid. But, when the tumultuous fermentation is over, when the temperature of the liquid drops, and carbonic acid gas is only disengaged in small quantities, the wine has then a great inclination to absorb air and to turn acid. This is always true, as far as regards wines that are weak, and, in this case, double care should be taken to avoid all causes favourable to the formation of acid.

As regards wines or worts of corn, of potatos, &c. experience proves that the access of air to these wines is not the only pernicious cause of acids being produced, but the nature itself of their composition, or, perhaps, the operations by which they are prepared favours the formation of acids considerably. In these worts the acetous and spirituous fermentations proceed together. From the beginning of the fermentation of worts, and even from the first movements, acid is formed. What I advance here is the result of exact experiments made upon grain, fermented in close vessels, to which air could not have access during the fermentation. So that it would be improper always to attribute the formation of acids, which is inseparable from the fermentation of an immensity of vegetables, it would be improper, I say, to attribute solely this formation to the contact of the external air, whilst in vessels, where this contact is rigorously impossible, acid is developed in the liquid in a smaller or larger quantity, and that at all the periods of the fermentation.

Section V.

ON LEAVEN.

Although we cannot very satisfactorily explain the mode of acting of leaven in the vinous fermentation, we know, however, that its presence is indispensably necessary. We know besides that, theoretically speaking, fermentable matter requires but a very small quantity of ferment to be converted into alcohol. In fact, experiments executed with exactness, prove that one hundred parts of sugar, converted into alcohol, only require, to this effect, one part of leaven, supposed to be dry, and, notwithstanding this, much more is made use of in practice. The superfluous quantity which is used, although frequently lost in the spent-wash, has been recognised as necessary.

Besides the leaven we have signalized as being used to determine and actuate fermentation, fermentable vegetables contain other substances, which fill the office of leaven, and which, in the act of fermentation, contribute themselves to the formation of leaven, which may be gathered on the surface of the fermenting liquid.

These substances are, in the musts of raisins and of all sugary fruits, a sweet principle, or liquid sugar of a peculiar nature. This principle is also formed with the fermentable sugars in the saccharification of farinaceous vegetables. In corn it is a substance known by the name of gluten, the discovery of which is owing to Beccaria, an Italian chemist.

The other substances which, in vegetables, fill the office of leaven, in contributing themselves to its recomposition, are very little known, and are designed, in chemistry, under the generic and vague name of extractives.

PART III.

On Distillation, properly speaking.

In the First and Second Parts of this work we have developed all the rules and principles proper to guide the distiller in the preparation of fermented liquors intended for distillation. We have now only to perform the task, which we have imposed upon ourselves, of giving an account of the most perfect and the most economical means of separating the alcohol.

In this Part we will then turn our attention to distilling-apparatuses, to their constructions, and to the theory on which they are founded.

CHAP. I.

On Distilling Apparatus.

Distilling apparatus are, as we have already said, the means resorted to, by distillation, to apply heat to the wine, and analyze it. By the aid of these apparatus heat is imparted, vaporization and condensation are effected, and alcohol is thus separated.

Thus the whole knowledge of distilling apparatus consists in the perfect understanding of the application of heat, of vaporization, and of condensation.

We have now to give a description of the various systems on which the most remarkable machines of distillation have been constructed.

These systems may be reduced to four, principal and distinctive:—1. Distillation by the simple apparatus. 2. Distillation by the wine-warming condensing apparatus. 3. Distillation by steam and by rectifiers. 4. Continuous distillation. For the three first we refer the reader to the First and Second Chapters of the work prefixed to the present.

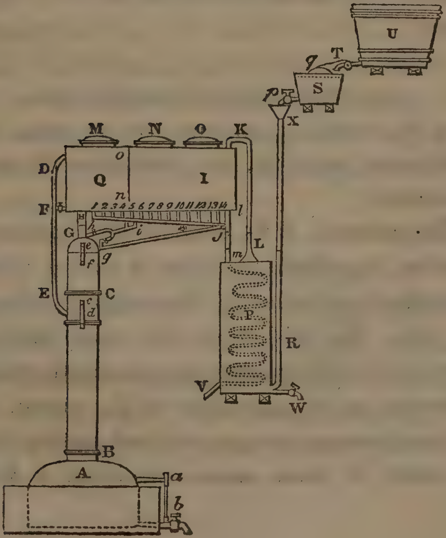
Section I.

ON CONTINUOUS DISTILLATION.

Mr. Cellier Blumenthal appears to be the original inventor of this precious system of distillation. A patent was granted for the continuous apparatus, of which we are about giving the description, to this gentleman, who afterwards assigned his rights to Mr. Derosne, who has almost entirely altered it. This ingenious technologist has brought it to a degree of simplicity and perfection which leaves nothing to desire. It is neither complicated nor expensive, considering the enormous mass of produce that may be worked with it. We will give a sufficient idea of the construction of this apparatus to show the advantages attached to it.

Section II.

DESCRIPTION OF MR. DEROSNE'S CONTINUOUS APPARATUS.



This apparatus is composed,—

1st, of one still, and sometimes of two.
2d, of a distilling column.
3d, of a rectifier.
4th, of a wine-warming condenser.
5th, of a refrigerator, or cooler.
6th, of a reservoir.
7th, of a regulator, furnished with a cock, which is opened and closed by a float.

Let us examine each of these parts successively, and follow figure 1.

I. THE STILL.

The figure shows but one still A, although two might be used, which would be more advantageous.

II. THE DISTILLING COLUMN.

In the distilling column the analysis, or, to speak more properly, the distillation of the wine is effected.

This column, B C, contains an ingenious mechanism, in which the wine is almost placed in immediate contact with the steam produced by the still. To this effect the steam meets with obstacles in falling, and presents itself multiplied obstacles to the ascension of the steam, which this body cannot conquer without passing through the wine; by these means the latter is divided, and so perfect a contact is established, that, in a very short time, the analysis is completed. In fact, the wine arrives, almost boiling, in the column, through the conduit D E, without having lost any part of its alcohol, and the more it descends towards the still A the more it is deprived of it, until it falls into the still in the state of spent-wash; the contrary takes place with the vapours supplied by the still A; on leaving it they are quite watery, and they arrive to the point C of the column in a very rich state, although this richness is always proportionate to that of the wine operated upon.

The little tube *c d* is a level necessary for the purpose of observing and conducting the work.

Thus it will be seen that this column of distillation, little elevated as it is, fills the same functions as a multiplicity of stills. It offers better results and greater effects, with a deal less copper, and presents the precious advantages attached to the system of continuity.

III. THE RECTIFIER.

The rectifier is that part of the apparatus which is marked C G; it surmounts the column, of which it is only a continuation, and contains the same mechanism. The spirituous vapours, such as they are, supplied by the column, pass through the rectifier, by the conduit H, into the wine-warming condenser, of which we will instantly speak. There they are rendered richer in alcohol, when the spirit is required to be of great strength.

This rectification is effected in the following way:—

The vapours condensed by the condenser Q I pass through the tube *h j* into the refrigerator, when they are sufficiently rich; but, if this is not the case, they may, by means of the retrograding pipes *g i* and *g j*, be brought back, whole or only in part, to the rectifier; there they meet with obstacles in their fall similar to those opposed to the falling of the wine in the column. These low wines undergo thus an analysis similar to that which the wine undergoes in the column, that is to say, that those low wines arrive in the rectifier much richer in alcohol than the wine that is worked, and that they leave this part of the apparatus in a state of richness about equal to that of the vinous vapours. Thus it is evident that these low wines have been deprived of their alcohol in favour of the spirituous vapours by which they have been analyzed. It is thus that, by means of the rectifier and of the retrograding pipes, the strength of the spirits may be regulated.

We may already notice with what art and ingenuity this apparatus has been constructed, and how successfully it fulfils the principles we have established on the art of distillation. In fact, those vapours that are the most watery are always in contact with the weakest part of the wine; and, reciprocally, those that are charged with the greatest quantity of alcohol, when they are to be rendered richer, are always in contact with the richest liquid. Thus every thing concurs to deprive the wine of its alcohol, without ever rendering it richer itself, and to dephlegm the vapours without ever mixing them with liquids poorer in alcohol than themselves. Let us well remark this advantage, for it belongs entirely to the system of continuous distillation: I may say more, it belongs solely to the execution of the inventor. The glass tube *e f*, the same as *c d*, serves to indicate the movement of the liquid in the column.

IV. THE WINE-WARMING CONDENSER.

This apparatus figured in Q I, like the preceding, has two destinations:—First, to condense the vapours with which it is supplied for the purpose of transmitting them either to the rectifier or to the worm. Secondly, to appropriate to the wine, intended for distillation, the heat which the vapours lose by being condensed.

It is evident that these functions are closely connected.

This condenser is a copper cylinder into which the wine arrives gradually through K L to leave it through D E. It contains a vertical worm, the pipes of which all communicate, by their inferior parts, with the pipes *h j* and *g j*, through the tubes 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14; and the vapours arrive in this worm through H, on leaving the rectifier G C, which they leave entirely condensed, through the fourteen tubes, or through *l m*; hence they proceed either to the rectifier or to the cooler.

In the execution of this wine-warming condenser conditions are to be fulfilled which are not easily surmounted. But such is the perfection of Mr. Derosne's apparatus, that almost every difficulty is most ingeniously removed.

These are the difficulties which present themselves:—

On one side it is necessary, in this system of distillation, that the common temperature of the condenser should not exceed that of ebullition, because, if this were the case, the wine which is much poorer in alcohol than the vapours it has to condense, could not fill this object, in virtue of the rules laid down, on the capacity of alcohol, of water, and of their vapours, for heat. On the other side, the wine, arriving through

B C, in the distilling column, should nearly be boiling; for, without this condition, instead of being analyzed by the alcoholic vapours it is about meeting, it would condense part of them to acquire its maximum of heat; and this would be a real defect, occasioning a loss of time and of heat; besides, the space through which it passes in the column, being calculated to operate its analysis, admitting it enters immediately in distillation, would, in the former case, not be large enough to deprive it of all its alcohol; and a large proportion of the latter would accompany it into the boiler.

Now, this is what has been done to conciliate these two dissenting conditions:—He has divided his condenser in two unequal parts, Q and I, by means of a diaphragm *n o*, which, having an opening towards the bottom of the condenser, allows the wine to arrive gradually through K L, and to pass continually from I to B. The pipes of the condensing-worm, which are immersed in the wine of Q, contain the most watery vapours; these, of course, abandon more heat by condensation: the wine contained in Q is warmer than that of any other part of the condenser; and, what is more, the wine which leaves it through D is always the warmest, in virtue of the laws of specific gravity.

A stop-cock, F, is fixed to the condenser for the purpose of discharging the wine when the apparatus requires to be cleaned.

V. THE REFIGERATOR OR COOLER.

This cooler, P, is a vertical cylinder, in copper, into which the wine is received through the conduit X R, from whence it passes into the condenser, through K L, which is fixed on the upper part of it. It contains a worm into which the vapours are condensed, and leave through V in the liquid state.

A cock, W, is used to discharge the worm when the working period is at an end.

VI. THE RESERVOIR.

The reservoir, S, contains the wine intended for distillation ; a cock, *p*, is fixed to it : the degree of aperture of the latter is regulated by the quantity of wine with which the apparatus is to be supplied, in a given time. But as this quantity may often vary, according to the unequal pressures caused by the unequal heights of the liquid contained in the reservoir, the height and pressure are consequently regulated by means of the following regulator.

VII. THE REGULATOR.

U is a small vessel into which the wine is introduced either by means of a pump, or runs into it naturally, if it can be so contrived. Its inferior part is provided with a cock which opens or shuts, according as the liquid sinks or rises in the reservoir.

This result is obtained by means of a float *q*.

MODE OF WORKING THIS APPARATUS.

It is filled through U, which is the highest part of the apparatus. Thus the wine comes into the still, and fills it to the height required, which is indicated by the glass level; then the distilling column is charged with that portion of the wine which is to oppose the passage of the steam. At this period the condenser and refrigerator are full; the introduction of the wine is suspended for a time, and is again continued by opening the cock *p* to supply the apparatus with a continuous stream of wine; this is only done when the wine in the still has been entirely deprived of its alcohol, and when the wine which is in the condenser is sufficiently hot to be introduced in the column. Then begins really the continuity, and all the previous work is only preparatory, although distillation has already begun.

There are two very distinct parts in this apparatus: one is that in which the steam mixed with the boiling wine, or with the low wines also boiling, undergoes by means of this mixture, a change which is the most conformable to the object of distillation; the other is that in which the vapours are only in contact with the wine through the intermediacy of the worms in which they are condensed, and their heat is abandoned in favour of the wine intended for distillation.

The first is evidently composed of the distilling column and of the rectifier; the condenser and the refrigerator constitute the second.

To account for the effect of the first part, let us remember the rules laid down on the various capacities of water, of alcohol, and of their vapours for heat.

Water, when arrived at 80°, cannot take any more heat without being transformed into steam; it occupies then a volume one thousand seven hundred times greater, and although the steam possesses the same temperature as the water by which it has been produced: that is to say, that it does not cause the thermometer to rise above 80°, yet it contains eight times more heat than water: for one kilogramme of steam mixed with seven kilogrammes of cold water give eight kilogrammes at 80°.

Alcohol, when pure,—that is, when weighing 42°,—passes into vapour at 62° temperature. Its vapour possesses the same temperature, and contains much less heat than the vapour of water;

for one kilogramme of alcoholic vapour mixed with three and a quarter kilogrammes of cold water, will only give a mixture of alcohol and water of 62° heat.

Vapour of water, which can only remain vapour at the temperature of 80°, will be condensed at a temperature at which alcohol will keep its vapourous state: in water, for instance, of 62° temperature, the vapour of water will be condensed, when, at the same time, that of alcohol will pass through it without undergoing the least condensation. If, instead of passing through water at 62°, this vapour passed through boiling wine, the water will be condensed in favour of the alcohol of the wine, which will be vaporized in relative proportions; and this in virtue of this well-recognized fact, that when wine, composed of a mixture of alcohol and of water, is in a state of ebullition: alcohol only takes the temperature of 62°, which is, of course, colder than that of water. What happens in this case? The vapour of the water, in traversing the mixture, is condensed, because it meets with alcohol which has only 62°; and as the latter cannot take any more heat without passing into vapour, it is vaporized by means of the heat which the steam of water has abandoned in being condensed.

Now, supposing the vapour which passes through wine in a state of ebullition to be itself a mixture of vapours, of water, and of alcohol, it is easily foreseen what will happen; the portion of alcoholic vapour will pass without losing any thing in the wine, whilst the portion of watery vapour will be condensed, and produce a relative quantity of alcoholic vapours.

Such are the phenomena which take place in the systems in which one still is distilled by the other. Such are, also, the phenomena which are observed in the distilling column and in the rectifier of Mr. Derosne.

The nearer the vapours are to the summit of the column, the richer the wine they meet, and the more they are charged with alcohol. As, in this case, the wine operated upon, and such as it is supplied by the condenser, is the richest; and as these vapours are greatly charged with alcohol, when they leave the column to enter the condenser, it must be conceived that this column has an immense advantage over the stills of Adam; and that it serves only and continuously to enrich the vapours, without ever enriching the wine, whilst, in Adam's apparatus, it is always necessary to render the wine rich, before richer vapours can be obtained.

The same phenomenon takes place in the rectifier; the low wines, which run back into it, present to the vapour a liquid much richer in alcohol than that which it has met in the column;

but these low wines only appropriate to themselves the water of these vapours, to which they abandon a portion of their alcohol.

The spirituous vapours, on leaving the rectifier, enter, through H, into the worm of the wine-warming condenser: even in this part of the apparatus they may be more dephlegmed, and from these they pass into the worm.

In this apparatus every thing is thus combined in such a manner as to cause all the vapours that are produced to be condensed in the wine-warming condenser; there they take the liquid state, but as they are in contact with wine which they have already rendered very warm, they cannot be cooled there. They are suitably cooled in the refrigerator, where they are brought into contact with cold wine.

The advantages of Mr. Derosne's apparatus are—

First, to be able, within a given time, according to the size of the boiler, to distil a much greater quantity of wine than can be done by any other apparatus hitherto known, depriving the same of all the spirits it contains.

Secondly, to be managed easily and without much labour, as there is no necessity for repeatedly charging the still; for two men may, at once, direct two or three of these machines, without fatigue, having no other charge than that of watching and supplying the fire with fuel, which, considering the small quantity made use of, is not very laborious.

Thirdly, the whole apparatus is of a moderate price, comparatively with those used heretofore, though it produces more spirit than any of them.

Fourthly, it occasions a great saving in fuel.

Fifthly, being simple in its mode of construction, not much room is required; it is not liable to obstructions; and is easily repaired, supposing it, which is not the case, capable of derangement.

Sixthly, to furnish, at will, spirits, completely rectified, even three-sixths in one operation.

Seventhly, to produce spirits of superior quality.

Eighthly, not the least quantity of water is wanted for the condensation of the vapours or to cool the spirits, the matter intended for distillation being always sufficient to absorb the heat of the whole of the vapours produced.

The largest of those apparatus cost about 5000 franks (£200); and one hundred and twenty hectolitres of wine may be distilled by them in twenty-four hours. Those of the next class cost about £104; and distil sixty hectolitres in twenty-four hours. The next cost £72; and distil thirty hectolitres of wine in the same time.

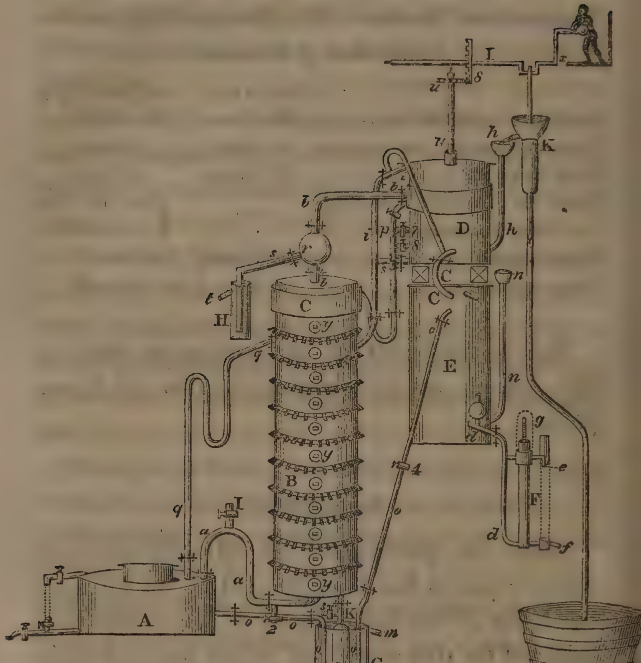
Comparison between Mr. Derosne's Apparatus and that of Bérard.

	BÉRARD'S.	DEROSNE'S.
Quantity of wine distilled ……	2364 litres	2364 litres
Time employed with two workmen	26 hours	12 hours
Coals consumed ……………	271 kilogr.	60 kilogr.
Made use of a large quantity of water for condensation ..	—	not one drop of water
Spirits obtained ……………	204 litres at $\frac{3}{6}$	249 litres $\frac{3}{6}$
Feints valuated at …………	31 litres.. $\frac{3}{6}$	no feints all

This is the result of an experiment made by Mr. Dunal, an enlightened distiller of Montpellier.

Section III.

Since the publication of Mr. Dubrunfaut's work, a patent has been granted by his Majesty, the King of the Netherlands to Mr. Cellier Blumenthal for this apparatus, which has undergone some alterations, and has been rendered more proper for the distillation of wash. We will give a description of it:—



A, boiler, producing the steam, which is to effect the distillation. B, distilling column, divided into ten pieces; each of which has from one to three screwing stoppers, *y y y*, by which means the inside may be seen and the hand introduced in every part of the interior. C, rectifier, placed on the top of the column, in which the low wines, returning from the condenser at the distiller's leisure, are rectified by the steam of water ascending from the column; the residue of the rectifier leaves through the tube *q q*, and runs into the boiler A.

D, wash-warming condenser; the conduits of which, intended to receive the steam, are of a peculiar form, presenting a large condensing surface. The matter to be distilled is constantly introduced into it by means of a pump *k*, through a funnel *h h*; the vapours arise from the column, are condensed, and heat this matter to 80°. The products of condensation are divided by the stop cocks, 7 and 8, which may be opened to send back into the rectifier those that do not possess the requisite strength. *u u* serves to stir the matter in the condenser, to prevent the heavy part from settling at the bottom.

E is a common refrigerator immersed in water.

F is a probe, into which the produce of distillation is received. In the middle branch *g*, covered with a glass bell, an hydrometer and thermometer are placed; *e f* is a branch formed by a glass tube; the products of distillation are seen running through the small tube *e*; they run through *f* into the vessels intended to receive them.

G is a vessel, into which the spent-wash falls; it comes in through *k*, and runs out through *m*.

This vessel fills the functions of an hydraulical safety valve.

H is a vessel with a plunging tube, in case (which has never happened) the matter in distillation should ascend into the column; it could not proceed to the condenser, for it would be stopped in the ball *r*, and through the tube *s*, run out by *t*, whilst the vapours would take their direction to the condenser.

I is a mechanism, formed by a bended axis and two wheels with teeth: it is moved by one man, who causes the pump, *k*, to play, and turns the shaft, *u u*, to the bottom of which two wings are fixed, for the purpose of continually agitating and preventing the matter from settling at the bottom of the condenser.

K is a pump, which brings the matter from the jack back into the funnel, *h h*, of the condenser.

MODE OF WORKING WITH THIS APPARATUS.

The still, A, is filled with water (the first time the column and condenser are also filled with water); the water in the still is brought to ebullition, the steam passes through *a a a* into the inferior part of the column, ascends from case to case, passes through the rectifier into the condenser, where it abandons its caloric in favour of the water contained in the latter. When this condensed water arrives at the probe, F, the pump, K, works without interruption. The matter proceeding out of the pump, having sent the water out with which the condenser has been filled, arrives in the column through *p p*, where it is met by the steam, which causes it to boil; it descends, from case to case, in a constant state of ebullition, and, arrived into the last case, it runs into G, and leaves through *m*. By opening the cocks 7 and 8 of the condenser, the lowest products of distillation are sent back into the rectifier; there they are dephlegmed, and return at a very high strength, which does not vary during the whole time of distillation.

As the water which passes in the state of steam, out of the still *A*, is to be re-placed; and as it is indispensable that this water should be very hot, it is drawn from the worm-tub, E, through *o o o;* before it enters the still it passes through G, where the matter is boiling hot. Cock No. 4 regulates the quantity of water which is to be introduced.

When all the matter has been pumped out, the process is continued for about a quarte rof an hour, for the purpose of exhausting the matter left in the column. The fire is then drawn off; cock No. 1, fixed on the tube *a a a*, is opened, as also cock No. 3, which is fixed to the tube K, on the lower part of the column. The next day the operations are re-commenced in the same way. The column and the condenser are left filled with matter.

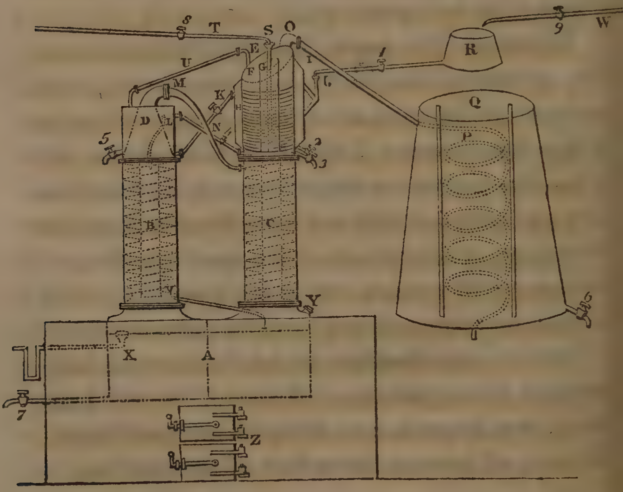
Several large distillers in the Netherlands have adopted this apparatus. Messrs. Claes, of Limbeck, near Brussels, have five of them; and Messrs. Dooms, of Lessine, have four of the same sort.

A great many of them are made for the purpose of rectifying spirits. By means of this apparatus spirits are constantly rectified at the strength of 28 Netherland's degrees: about equal to pure alcohol.

Section IV.

There is another system of continuous distillation, that of Mr. Baglioni.

If the system of continuity belongs to Mr. Blumenthal, this justice is due to Mr. Baglioni, that he was the first who had the ingenuity of applying the distilling column to the neck of the still.



DESCRIPTION OF MR. BAGLIONI'S APPARATUS.

A, double still, having a copper partition, in the middle, which divides it from top to bottom; there is a hole at the lower part of the partition, so as to establish a communication between the two stills.

B, first distilling column.

C, second distilling column.

Each of these columns contains an evaporator in the form of a double vice of Archimedes.

D, is a common capital, or head, belonging to the first column.

E, $\frac{3}{6}$ capital or condenser, for the purpose of making strong spirits.

F, column of the head, containing an evaporator constructed in the form of Archimedes's vice.

G, space left in the middle of the head, to receive the water necessary for the condensation of the low wines.

H, envelope of the column which receives the cold wine through the funnel J.

I, tube, having a regulating cock; it takes the wine from the tub R into the funnel J.

J, funnel which takes the wine in the envelope H by means of a double branched tube.

K, tube which takes the wine from the envelope of the head into the lower part of the common head.

L, tube which introduces the wine of the envelope of the common head on the evaporator of the first column.

M, tube which takes the spirituous vapours of the first column into the upper part of the second, which sends it into the pipes contained in the head.

N, tube which takes the wine of the envelope of the first column, on the evaporator of the second; this tube is only used when spirits of a low strength are to be made.

O, tube by which the spirituous vapours are taken from the head into the worm.

P, worm.

Q, worm-tub.

R, tub supplying the apparatus with the wine; it is to be alimented by a larger tub.

S, funnel, followed by a tube which takes the cold water into the middle of the column of the head.

T, tube which takes the water into the funnel S.

U, air-tube.

V, receives the spent-wash at the bottom of the first column, from which it proceeds into the second still, through a pipe.

X, funnel communicating with the outside of the still by means of a tube; it is used for the purpose of evacuating the spent-wash, which, when it is above the level of the funnel, runs out of the still.

Y, man-hole.

Z, doors of the furnace and ash-hole.

W, tube which aliments the tub R.

No. 1, Regulating cock supplying the apparatus with wine.

2, Cock to discharge the envelope of the head.

3, Cock to discharge the middle of the column of the head.

4, Cock which takes the wine of the envelope of the common head on the evaporator of the second column.

5, Cock to discharge the envelope of the common head.

6, Cock to discharge the worm-tub.

7, Do. to discharge the still.

8, Do. to bring the water.

9, Do. to aliment the tub R.

MODE OF WORKING WITH THIS APPARATUS.

The still is filled with water, which is brought to ebullition. When the distilled-water runs out of the worm the operation should commence. Cock No. 1 is about half opened, so as only to give passage to half of the wine it is capable of furnishing, the interior G of the head is filled with water by Cock No. 8.

The wine runs through the funnel J, into the middle of the envelope H, which is filled as high as the tube K; it enters then through this tube into the lower part of the envelope, and, when the latter is full, the wine runs from this part through the tube L on the evaporator.

The wine runs on the evaporator of the first column on which it is distilled, and the spent-wash runs out at the bottom of the column.

The spirituous vapours rise into the head D, and proceed through M into the upper part of the second column; they then rise into the pipes of the head, in which they may be more or less condensed; the spirituous vapours alone can traverse it, and the phlegms return back into the first column, and are again distilled before coming into the still.

In this operation the wine is distilled on the evaporator of the first column, the phlegms on the evaporator of the second, and the spent-wash falls into the still, which is the most distant from the evacuating funnel X, where it remains long enough to be entirely deprived of its alcohol.

The various strengths are obtained by the degree of cold given to the head, by means of the water introduced by Cock No. 8.

In Mr. Derosne's apparatus the wine is in immediate contact with the steam in the column, but in Mr. Baglioni's the contact is effected through the medium of the coppers of the evaporator.

CHAP. II.

On the various Flavours by which Spirituous Liquors are characterized.

Although all spirituous liquors are, like the wines from which they proceed, essentially composed of water and alcohol, the fact proves, however, that those flavours are as multifarious as those of the wines and fruits susceptible of undergoing the vinous fermentation. Thus we not only find distinct variegations between the tastes of spirits, of raisins, cherries, sugar-cane, rice, grain, and potatos; but these differences vary themselves, as much as the divers species of the same fruit, the process of distillation being the same. Hence, the distinction established between the brandies of Languedoc, Bordelais, Armagnac, Cognac, Aunis, Barcelona, Naples, &c. although these liquors are all the production of the distillation of wines from the raisin; but the quality of raisins differs according to the soils and the climate in which they are cultivated; and as those varieties of flavours are always reproduced in the wines, so they will appear again in the products resulting from the distillation of those same wines.

These facts are incontestible, and known by every body.

These peculiarities of tastes and flavours, which give us the means of distinguishing one spirituous liquor from the other, we are no more allowed to consider as identic than to consider as such the various fruits from which they may be produced; thus we distinguish the Kirsch from the spirits of the raisin almost as easily as we distinguish cherries from the latter fruit, so that there must be in spirits, where our chemical means do not recognize any thing more than water and alcohol, some other peculiar bodies in such small proportions as to escape analysis, but the properties of which are sufficiently energetic to affect our organs and verify their existence. Without the admission of this hypothesis it would be necessary to suppose that alcohol, which is the constitutive and distinctive principle of vinous liquors, is not identic in all. This supposition might be well founded, but it cannot be satisfactorily demonstrated. It is, in fact, more interesting to science than to practice, and we shall be able, without admitting it, to find in our chemical theory, means of explaining the causes of the various tastes and flavors of spirituous liquors; these means of solution will appear the more likely to be true, as they will be consolidated by material proofs furnished by the practice of the art. We will consider essential oils and acids as the only causes of the difference we remark in spirituous products, and it will be seen, by the applications to which they will lead us, that if there exist any other causes, we cannot lose much in practice by not knowing them.

Section I.

ON ESSENTIAL OILS, CONSIDERED AS THE CAUSES OF THE TASTES AND FLAVOURS OF SPIRITUOUS LIQUORS.

The chemical properties of essential oils are to be volatile, odorous, and without viscosity; they are often acrid and caustic, and sometimes mild; they are little soluble in water, but are easily dissolved in alcohol; they are spontaneously inflamed when a body in combustion is presented to them; and although they are volatile and lighter than water, they can only be vaporized at a much higher heat.

Essential oils are commonly known by the name of essences. They are considered as being the material causes of the perfumes of flowers and fruits, out of which some may even be extracted by means of distillation. Such are essences of roses, of lavender, citron, neroli, anis, juniper, &c. They are besides considered as the causes of the flavours of the greater part of the substances affecting the smell in one way or the other, either good or bad, even in those from which it has not yet been possible to extricate them. Thus wines owe their aromas, their flavours and even their tastes to the presence of essential oils. Nothing is then of greater moment than to recognize the same causes by the same effects, in the products of distillation.

In fact, the existence of essential oils in vinous liquors being once admitted, it will be conceived that, when these liquors are submitted to distillation, the essential oils are placed in circumstances favourable to their vaporization, although proportionably to the quality of the wine. They will thus be vaporized absolutely according to the same laws, which, in a mixture of water and alcohol, favour the vaporization of water, with alcohol in proportions, which vary ; and as, in this instance, the alcohol takes away a quantity of water, proportionate to the alcholic richness of the mixture, so will these mixed vapours carry off a quantity of essential oil proportionate to that which the wine contains. The vaporization of essential oils is also proportionate to the temperature of ebullition of the mixture of water and alcohol ; and as this temperature is in direct relation with the proportions of water and alcohol contained in the mixture, we may, with certitude affirm that the quantity of essential oil that will be vaporized, will be proportionate to the quantity of water contained in the wine submitted to distillation. Let these facts be well remembered, the knowledge of them is of the greatest importance to the perfect understanding of distillation, and on them are founded the operations of rectification, of which we soon will speak.

Thus the taste and aroma of the wines being transmitted to the spirituous liquors, with the essential oil, in the act of distillation, it is clear that those wines that possess an agreeable taste and aroma will communicate it to their spirits; it will be the same with wines having an unpalatable taste. If distillation exercise any influence on the conservation of this aroma, the distiller must be acquainted with it, so as to regulate his operations accordingly. Thus he shall try to work in such a manner as to keep in his spirits as much aroma as possible, when this aroma happens to be generally pleasing to the palate; and, on the contrary, deprive his spirits of it, when this is not the case.

Before we treat on the influence of distillation, on the taste and flavour of spirituous liquors, it will be adviseable to direct our attention to some considerations proper to demonstrate the presence of essential oils in spirits. We have a great many facts of admission in favour of this hypothesis, and we know none against it.

If essential oils were not soluble in water or in alcohol, we might affirm that spirituous liquors do not contain them, because we have them in a perfect state of limpidity; but this is not the case, and we know by experience, that *Eau de Cologne*, which is very limpid, is nothing but a mixture of $\frac{3}{6}$ and of divers essences; and what is more, in the distillation of wines, by the simple apparatus, in which low wines are at first drawn off, these often present a more or less nebulous appearance, according as they are more or less rich in alcohol; and this nebulosity is besides dependent on the degree of acceleration with which they are distilled; that is to say, that they are more nebulous when the fire is strongly actuated, a superabundance of vapours being thus formed. These two phenomena are easily explained by means of the hypothesis of the essential oils. In fact, these are much less soluble in water than in alcohol, and according to the theory we have already established with respect to vaporization, we know that the less alcohol wine contains, the larger the quantity of essential oils that will be vaporized, because they are then exposed to a higher temptation. Thus, in this instance, every thing tends to introduce in the low wines a quantity of essential oil greater than they can dissolve, every thing tends to vaporize this oil in greater quantities, the alcoholic state of the wine, the temperature of its ebullition, and the quantity of water that is vaporized. Hence, the nebulous state of the low wines, which is greater in a tumultuous distillation in which, while the temperature is forced, more water passes into vapour. Hence, the disappearance of this nebulosity in the process of rectification, in which case, essential oils finding less favourable conditions to their vaporization, find at the same time, in a more alcoholic liquor, one condition favourable to their dissolution. We thus explain, in a satisfactory manner, how those low wines are nebulous, and how by rectification they give clear spirit, also, how the latter contains a smaller quantity of essential oil than the low wines by which they have been produced.

Lees taste.—Mr. Aubergier, in the exact experiments which he has made to recognize the cause of the disagreeable taste of brandy made from the grounds or lees of raisins, has demonstrated that this taste is produced by an essential oil contained in the skin of the raisin, of which the latter is deprived in the act of distillation, in small quantities it is true, but sufficient to infect the spirituous produce. He has succeeded in isolating this oil, and he has recognized that its action is so energetic that a few drops are sufficient to give the obnoxious taste of the lees to a pipe of good brandy, containing six hundred litres. Thus, we need not be astonished, with the precious knowledge of this fact, that it is most difficult to succeed in separating from a spirituous produce all the essential oil which constitutes its taste and flavour, when so small a quantity suffices to aromatize so large a bulk.

But do we not know besides that it is by the aid of the essential oils of a great number of vegetables that the *liqueur makers* succeed in augmenting, immensely, the number of spirituous liquors, the tastes and flavours of which are diversified by these means. Rose-water simply mixed with spirits at 33° and sweetened with a small quantity of sugar produces that *liqueur* which is known by the name of *cream of roses.* In this case the distiller being master of giving to the liquor the perfumes of such plants as he thinks proper, only makes use of such as affect the taste and the smell agreeably ; in fact, he works for the consumer, and the flavour he gives to his spirits is always energetic enough, by its properties, its quality or quantity, to mask that which is natural to the alcohol made use of.

Empyreuma taste.—Spirits of grain and of potatos, besides the disagreeable taste and aroma they possess, find in distillation causes which contribute to give them an essential oil much worse than that furnished by those vegetables. In fact, the systems of fabrication followed up to this day cause the matter to be distilled in the state of paste; and, notwithstanding the precautions taken to prevent it from sticking to the bottom of the still, and there burning in the form of a crust, this accident often happens; hence, the taste of fire or of empyreuma which is often recognized in these spirits, and which cause them to be much depreciated by the trade. The cause of this taste is still the immediate consequence of an essential oil, produced by the burning of the paste to the bottom of the still. We know, in fact, that all vegetable substances when torrefied, give among other products, an infective essential oil, known by the name of *empyreumatic oil.* Now, this is what happens in this case, the oil being once formed, is dispersed in the liquid in distillation, and passes, together with the water and the spirits, into the worm. This taste of empyreuma has caused the distillers of the North, in particular, to aromatize their spirits: they thus disguise the bad flavour, to a certain degree; but this essential oil is acrid and extremely caustic, and if not taken away from the liquid, it always keeps a burning taste, which pleases only those who are used to it.

This taste of empyreuma which is found to be so energetic in the produce of the distillation of pastes, is not produced in this instance alone; and all wines submitted to distillation, when still containing some solid matter in dissolution, such as sugar, leaven, or any other organic substances, may produce, when distilled on the naked fire, an empyreumatic essential oil, the taste and flavour of which is communicated to the spirits. In fact, when wine is distilled, the temperature of its ebullition is represented by the combined relations between the temperature of ebullition of each of the substances, which enter in its composition, and this temperature is besides dependent on the proportion in which these substances are mixed; so that when wine submitted to distillation is composed of sugar, of water, and of alcohol, the temperature of its ebullition is the common proportional of the temperatures which sugar, water, and alcohol, would separately require, to pass to the state of vapour. Of these bodies sugar requires the highest temperature to be reduced to gas, and alcohol is converted into vapour at the lowest. Thus, the more sugar wine contains, the higher temperature it will necessitate to pass to the state of vapour. In this case it is evident that the sugar takes in the mixture its temperature of ebullition, and by those means alone, that of the mixture can be increased. Sugar is thus placed under conditions favourable to its decomposition, which the water and the alcohol to which it is mixed try constantly to neutralize, in virtue of the principles laid down, on the transmission of heat.

We know, on the other side, by experience, that sugar, like all other organic substances, cannot pass to vapour, without undergoing an analysis, by which its nature is changed. Thus, when distilled alone it gives water, carbonic acid gas, and empyreumatic oil, which is converted into vapour, and carbone which is left in the retort, in the form of a black couch.

Let us now apply the knowledge of these facts to the distillation of a mixture composed of sugar, of water, and of alcohol, and we will easily conceive what influence the fire may have on the taste of the spirits. The sugar would here undergo an analysis, which, it is true, would be very slight, but it world be sufficient to give birth to some atoms of all the productions we have just mentioned. Among these productions, which are those that may, when reduced to vapour with the alcohol, modify the taste of the latter? It cannot be water, for this is insipid; it cannot be the carbonic acid gas, for this gas cannot be condensed: then it must be the empyreumatic oil.

It can now be easily explained, how the naked fire can have a pernicious effect on the tastes and flavours of the products of distillation, by giving birth to this oil.

This influence will shew, besides, how important it would be to the quality of the spirits, to submit to distillation matter that is not only perfectly fluid; but not to operate upon any other matter, but such in which the alcoholic decomposition has been the most perfect possible.

We may thus be well convinced, from the facts which I have just stated, that one of the most influential causes of the tastes and flavours of spirits, belongs to the essential oils contained in the vegetables, or to those that are formed during the act of distillation, by the torrefaction of organical substances. All we will say hereafter on that subject will tend to consolidate this conviction.

Section II.

OF ACIDS, CONSIDERED AS THE CAUSES OF THE TASTES AND FLAVOURS OF SPIRITUOUS LIQUORS.

Take some spirituous liquor, of any description, and of any strength; plunge a band of proof-paper into it, that is to say a band of paper coloured in violet by violets, or in blue by sunflowers. After it has remained a few minutes in it, it will be observed that its colour is become more or less red, from violet or blue, which it was before. This change of colour is a certain sign by which chemists ascertain the presence of acids. Thus, as the products of distillation turn the colours of the violet and sunflower into red, there can be no doubt but what they contain acids. We will easily account for the presence of acids in referring to what we have said on the subject of fermentation: we have seen, in fact, when treating on that part of the art, that all wines, and all fermented liquors, retain acids, in smaller or larger quantities, of various descriptions, according as these acids are furnished by the vegetables themselves, or whether they are the results of fermentation. Thus, nothing is more natural than to find in wines of the raisin tartaric acid, because the latter is immediately connected with the composition of the raisin; cider and perry have both all the malic acid of apples and pears inherent to their composition; the wines of cherries and of gooseberries present also the malic acid of those fruits, and malic and acetic acids are generally found in worts of grain and of potatos, although those vegetables do not contain them. In the latter case, these acids are formed at the expense of the alcohol in the vinous fermentation. Wines, whatever be their nature, contain always acids; and, from hence, nothing can be more easily explained than the presence of these acids, in a smaller or larger proportion, in the products of distillation.

The properties belonging to these kinds of acids, which, in chemistry, are classed under the generic name of vegetable acids, are—to be specifically heavier than water; to enter into ebullition at a higher temperature; and to turn the colour of violets or sunflowers, more or less, into red; to be colourless; soluble in water and in alcohol; and to have, more or less, a sharp taste. Acetic acid alone appears to have a flavour which is known to every body: it is that of vinegar.

The latter acid, which is formed in all wines, and in all spirituous liquors, and which is always the produce of the vinous fermentation, possesses a remarkable property; it is that of combining with alcohol, and forming with the latter a body known by the name of acetic ether. I will not endeavour to find out whether this body might not, in a small proportion, be found in the spirits which is sold by the trade, and thus modify their tastes and flavours; this point has not been studied, and it would be venturesome to give an opinion on that subject.

It is sufficient for me to have demonstated that acids exist in spirituous liquors, and to have indicated in virtue of what principles they are found in them.

Acids necessitate, the same as essential oils, a higher temperature than water to be reduced to vapour, and every thing we have said on the causes by which the vaporization of essential oils, as determined in distillation, is applicable to acids. Thus, like essences, acids are placed in wines under conditions nearly equally favourable to their vaporization; and every operation tending to keep the aroma in the wine will also keep the acid into it, and *vice versa.*

Let it, however, be remembered, that if essential oils can, according to their nature, affect our organs in an agreeable or a disagreeable manner, this is not the case with acids, which always contribute to give a sharpness to the liquor. It is thus that spirits extracted from wines strongly sour, such as perry and cider, have always a tart taste, which is not met with in spirits of raisins, the operations of distillation having been, for both, conducted in the same way.

Section III.

INFLUENCE OF DISTILLATION ON THE TASTES AND FLAVOURS OF SPIRITUOUS LIQUORS.

I will not here endeavour to investigate whether acids and essential oils, which we consider as the causes of the tastes and flavours of spirituous liquors, are transmitted to the latter in the state in which they are found in those vegetables; or whether they do not undergo, during the fermentation or distillation, certain changes, by which their characters and properties are altered; nor will I inquire whether those essential oils might not often be the results of the preparatory operations to which vegetables are submitted, before they are brought to the state of spirituous liquors. Similar researches belong, entirely, to study and science. It is sufficient for me to admit that acids and essential oils are found in spirituous liquors, and that they are transmitted to them by their wines.

The south of France supplies us with almost the whole of the spirits we consume. Those that are reputed to be the best, such as the brandies made at Cognac and Armagnac, are sent to us, from the countries where they are made in the state in which they are consumed; that is the Cognac at 22°, and the Armagnac at 19°; and they are known by the name of proofs. The latter kind of spirits are, in great part, at least, as far as regards those of Languedoc, extracted out of the same wine which supplies the whole of France, and many foreign countries with enormous quantities of spirits at $\frac{3}{6}$. The object of the distiller in making $\frac{3}{6}$ is to reduce the alcohol in weight and in volume, and to economize thus for the consumer the expenses of casks, which are considerable: a cask of 600 litres being often sold from 40 to 50 francs; and also to lessen the costs of carriage. It is known that this $\frac{3}{6}$ abstract being made of a small quantity, which is used in certain arts, is totally consumed as beverage. To this effect, when it has arrived in the places of consumption, the dealer lowers the strength down with various proportions of water, according as he wishes to have it at 18°, 19°, or 22°, and in this state it is delivered for consumption. Long ago the public, and, of course, the trade, have made a distinction between the brandy made with $\frac{3}{6}$ spirits and with water, and that which comes proof from the south. But what difference can there be between those two sorts of brandy? Both proceed from the same wine; the only difference existing is, that the brandy which arrives at proof strength has not been dephlegmed to so great an extent as the $\frac{3}{6}$ which has served to fabricate the other. In one instance, the wine has been deprived of its alcohol, at the strength of 19°, in the other at 33°. If it were admitted, as it has often erroneously been done, that spirituous liquors are, rigorously speaking, nothing but different mixtures of alcohol and water, one might be led to believe that no differences can exist between those two sorts of brandy, as, in this case, the $\frac{3}{6}$ at 33° would only be a mixture of alcohol at 19°, or 22°, deprived of a portion of its water. But this is not the case; and the taste of the consumer, whilst it distinguishes perfectly the proof brandy from that of $\frac{3}{6}$ lowered down with water, proves sufficiently that there is a difference, into the cause of which we should inquire.

This cause belongs to the essential oil of the wine, which the consumer estimates as a good quality, because it happens to be of a sweet nature; and it will be easy for us to explain how spirits separated from wine at 19° or 22° contains, necessarily, more essential oil than that made of $\frac{3}{6}$. Let us but remember the laws we have established, in the first section of this chapter, with respect to the vaporization of essential oils, and we shall be brought to this conclusion, that the more alcohol is drawn at a high strength, the less essential oil it carries away, for this very reason, that it has not necessitated so high a temperature to be reduced to vapour. This is what takes place in this instance, where alcohol is drawn, on one side at 22°, and on the other at 33°; it is thus not astonishing that brandy at $\frac{3}{6}$ is not of so good a quality as that which is made at proof.

We may thus lay down as a rule, that when the taste of a liquor pleases the consumer, the way of preserving it, is to draw it from the wine at the strength it is consumed.

This rule, which we have established with respect to the influence of the strength at which the alcohol is separated, on the vaporization of the essential oil, has no exception. Take any spirituous liquor, saturated with any essence whatever, submit it to distillation, *Eau de Cologne*, for instance, the spirituous produce, which you will thus obtain, will have lost, by this operation, a great part of its essential oil, and, of course, of its aroma.

No doubt an objection will be started here, which is founded on the presence of acids, and on the laws which I have already signalized as being the same for their vaporization, as for that of the essential oil. It will be objected that if, on one side, spirits at $\frac{3}{6}$ lose a part of their flavour and their aroma, by the greater concentration which their alcohol has undergone; on the other side, this cause, obnoxious to the flavour, must be favourable to the taste; because alcohol drawn at $\frac{3}{6}$ must retain less acid than that which is drawn at proof; this objection might be well founded, and, in this instance, theory would be in contradiction with practice, if we did not find in the state of the wine and in the facts themselves, a satisfactory answer to this objection. I have said, in general thesis, that all wines, whatever be their nature, had, at least, one acid connected with their composition: this assertion is true; and we may easily be convinced of its veracity by means of paper coloured with violet or sun-flower. But what I have not said, and which I must announce here, is, that the wine of raisins is, of all the wines, that which contains the least acid. This body generally is found in it in so small a quantity, that it exists in it in smaller proportions than in the spirituous produce at 22° of other wines, such as those of grain, cider, or perry; the nature of the acid may, perhaps, be different, and exercise a less disagreeable influence on the quality of the spirit. Thus, in the process of distillation, the taste of the consumer, and experience, ought to teach us to recognize whether the preservation of the aroma is more favourable than the loss of the acid; and whether to free it, on one side, from an insignificant defect, represented by a small quantity of acid, would not be losing, at the same time, a precious quality, represented by the flavour. These two alternatives should be considered, and the mode which is the least unfavourable to the produce must be adopted. Thus, in the case under consideration, that is, as regards the spirits of raisin, the weak acid they contain is a small defect, which is sufficiently masked by the greater sweetness which a greater proportion of essential oil gives to the spirits; thus, it is more advantageous to the produce to preserve the aroma than to take the acid away.

In such cases, when the essential oil is a quality to the liquor, the difficulty which I have signalized presents itself, and then the distiller must take these inconveniences into consideration, and act according to his experience and to the taste of the consumer; but, in all cases, and they are very numerous, in which the essential oil shares the animadversion of the trade, when it constitutes two defects in quality, as is the case in spirits of grain and of potatos, the difficulty is removed, and any operation which will tend to make one of the two defects disappear, will, at the same time, contribute to remove the other.

Section IV.

ON RECTIFICATION, CONSIDERED AS THE MEANS OF CORRECTING THE TASTES AND FLAVOURS OF SPIRITUOUS LIQUORS.

We have already been able to see the object of rectification, when speaking of distilling apparatus; we have seen that it is by the aid of this operation that alcohol is brought to a greater strength. Thus, in all systems of distillation, all dispositions tending to dephlegm the spirits, belong to the art of rectification.

In the simple and in the wine-warming apparatus, liquors are rectified by passing them successively through the still, until they have acquired the necessary strength; and it must be seen that, in this system, the weaker the wine is, the ofener it must be re-passed. These repeated operations are called *cohobations*.

In the improved apparatus of Adam and Berard, the multiplicity of stills, which are warmed, become richer in alcohol, and are distilled by the steam constantly supplied by one to the other, truly corrects and rectifies the spirits; and, in fact, as we have already seen it, this disposition causes the spirituous vapours to be richer; and that part of the apparatus which is called *rectifier*, favours rectification in two ways: 1st. It dephlegms the vapours which pass through the worm attached to it. 2d. It brings back to the still the feints which are condensed in it, to submit them to another analysis.

This also takes place in the continuous apparatus or distilling column; the rectifier and the wine-warming condenser are both agents of rectification. Rigorously speaking, distilling is bringing wine to ebullition, and bringing the vapours, such as they are produced, back to the liquid state, without causing them to undergo any other change, as is practised with the simple condensing apparatus, and to separate, by any means whatever, the watery from the alcoholic vapours, is rectifying. Such are, at least, the variegations established between distillation and rectification; and, although these distinctions are not rigorously exact, we ought, nevertheless, to be acquainted with them, to understand well the adopted language.

We have shewn, in the preceding section, the influence which distillation might exercise over the taste and flavour of spirits, we have observed the difference of quality which alcohol possesses, according as it has been drawn off at 22° or 33°, and we have explained the causes of it.

Thus, it may already be seen of what utility the knowledge of this fact may be to the distiller, under an immense number of circumstances. In fact, if it be of any moment to the taste and flavour of the spirituous produce, to be made at different strengths, the distiller has the most efficacious means at hand of preserving partly, or removing those tastes and flavours; and these means belong entirely to the process of rectification.

The rectification of spirituous liquors may thus be considered, in the distiller's art, under two different aspects:—1st. It serves to con centrate alcohol;—2d. It serves, moreover, to separate the latter from the two bodies which especially constitute the various tastes and flavours by which it is distinguished, essential oils and acids.

Thus, this twofold property of rectification, these two intimate effects, which are combined in this operation, being once well recognized and appreciated, there remains nothing but to apply them with judgement to the practice of the art of distillation.

When wines, possessing, like those of Cognac and Armagnac, an aroma, which is not very intense, although distinct, are worked by distillers; and if this aroma constitutes alone the merit of the produce, care should be taken not to lose it by distillation, and to obtain this result as much as it is possible to do it, by any means known; the spirits should only be rectified at the strength required for consumption, 22°, for the Cognac and Armagnac, which is made in imitation of the latter; and 19° for the Armagnac, properly speaking. If it were rectified at a higher strength, at 33°, for instance, to be lowered down afterwards with water, this spirit would have lost, by rectification, a large portion of essential oil, and, of course, a part of its flavour, of its quality, and value.

It is the same with the spirits of almost every wine of the raisin; and if distillers do not conform to this general rule, and persist in transforming the greater part of their wines into $\frac{3}{6}$, instead of making proof goods, it is because there is a greater consumption of $\frac{3}{6}$ brandies than of proof goods in the market they supply; not that the latter have not quality enough, but because the expenses of carriage, which they are subject to, cause their price to be higher than the common consumer could afford to pay.

As for these kinds of brandy the portion of acids they retain is so small, that it lessens its value in no ways whatsoever, so that it is better, with respect to the quality, to leave the acid to it, than to lose the flavour by rectification.

As regards lees-wines, which are much more acetous than other wines, and which contain still the skins, where the infectious essential oil is seated, it must be conceived that if the spirit were drawn at 33° and afterwards lowered down to 22° with water, this spirit would be better than if it had been drawn at the strength of 22°, for this very reason, that it would contain less acid and less essential oil. This is the case with all wines bearing a disagreeable flavour or much acid, or both of these defects together.

For these kinds of wine, it will always be advantageous to the quality of the produce to draw the alcohol at the highest standard possible.

It might even be possible, in making every use of the process of rectification, to repeat and conduct it in such a way as to succeed in completely freeing the alcohol of its bad qualities, that is of its essence and of its acid.

Thus, for spirit of lees, it would not only be requisite to draw it at 33°, as is done in Languedoc, because, in this state, the spirit lowered down with water to proof has yet a strong taste of the lees, but after it has been brought to that strength it would be advisable to rectify it over and over again, before it is delivered for consumption. It is thus that, in the numerous potato distilleries at Paris, spirits at 33° have been made entirely free from the taste and flavour of the vegetable, and sold as $\frac{3}{6}$ of raisins, after having been mixed in equal bulks with the latter. In working spirituous liquors which would not admit of an augmentation in price sufficient to defray, amply, the expenses of rectification, the distiller would be working against his own interests were he to rectify them. It is for him to make this calculation of economy, and to set his work in harmony with his interests; our task is only to signalize the influence of rectification on the quality of the spirits.

It is not necessary to remark what advantages are attached to the use of improved apparatus, with respect to rectification; in this case particularly they are indispensable.

Distillers, guided, no doubt, by an incomplete knowledge of the theory of operations, have tried to turn alkalis, potashes, salt-worts, and lime to advantage, in rectifying spirits, but I am not aware that these agents have had the desired effect. Others, also, have been employed, to the same effect, earthy bodies such as lime-stone, plaster, magnesia, and clay; but I am not aware that the effects of these agents have been more successful, and I persist in declaring the rectification and concentration of alcohol to be the best means of clearing spirits from acids and from essential oils.

But let the object of rectification not be falsely interpreted, let it not be thought that, by means of this sole operation, the tastes and aromas of the various spirits will be completely altered, and that it will be possible to sell ground or lees wine spirits for proof brandies, kirsch for rum, &c. this would be a mistaken notion; rectification frees alcohol from any tastes or flavours which do not belong to it, but it does not substitute any other to it. Thus, we have seen that the fecula distillers at Paris, after having extracted the alcohol and improved it by rectification, mix it afterwards with raisin-spirits to sell it as brandy. It will thus be seen that by the mixture of the two liquors, one of which only is freed from its distinctive qualities, a liquor is obtained, which possesses the taste and flavour of that which has not been cleared to the same extent, with this difference, however, that this taste and flavour is then shared by a greater mass of liquid and must, of course, be considerably attenuated, which is the case. The greatest part of the consumers do seldom find out the difference between spirits made with pure $\frac{3}{6}$ of raisin and those which proceed from those same $\frac{3}{6}$, falsified with spirits of potatos, but connoisseurs are not deceived by it, although the difference is not very sensible.

CHAP. III.

On special Distillations and on the Choice of Apparatus.

Special distillations may be as numerous as the vegetables capable of furnishing elements to fermentation. It must have been noticed, in the preceding chapter, that the nature of the wine operated upon, and the taste which it is necessary to give to the spirits, may command some particular mode of working to be followed, according as the tastes and flavours are to be removed or left in the produce. But if the system, upon which the means of correcting or preserving are founded, has been well conceived, it must infallibly have been remarked that these belong to the process of rectification, that is to say, to all mechanical operations, the object of which is to give to alcohol a greater concentration.

The object of improved apparatus being to effect the rectification of spirits with greater economy, it is evident that, in this respect, the choice of apparatus is not attended with difficulty, and that such as present the most economical advantages must be preferred. In fact, if the object of those improved systems is to produce at once spirits at the highest strength required, they are equally proper for the preparation of spirits at a lower standard. An improved apparatus may thus be used for the purpose of preparing $\frac{3}{6}$ and proof goods with advantage; and if, in the first case, its economical superiority over simple apparatus is greater than in the second, its advantages, in the latter case, are of sufficient moment to render it preferable.

We shall not direct our attention any further to the choice of apparatus, and we shall be justified in thinking that we have offered a sufficient and unexceptionable guide in our economical questions, if there did not exist a powerful consideration which may sometimes cause the distiller not to be influenced by the question of economy, in the choice of an apparatus. I allude to the divers cases in which the distillation is to be effected on matter which retains insoluble substances in a state of suspension. Such is that of the distillation of lees, such is also that of grain, and of potatos in the natural state.

This particularity, causes us to admit a distinction in distillation, and we will consequently divide the latter into two kinds: the first we will call distillation of fluid matter, the second distillation of semi-fluid semi-solid matter.

We will treat separately of each of those kinds of distillation, and assign to each of them the apparatus and modifications which may be suitable.

Section I.

DISTILLATION OF FLUID MATTER.

The distillation of fluid matter is that which is effected on wines containing little or no organical substances in suspension, although they may retain a more or less considerable quantity of the latter in dissolution, such are the wines of the grape, of molasses, of saccharified fecula, of beer, and other extracts of grain.

These kinds of wine are those that offer the least difficulty to distillation; it may be effected in any kind of distilling apparatus; so that, in this case, that which is the most perfect may at once be chosen, without the least apprehension of inconvenience resulting from the state of the wine. Nothing but some considerations depending on the fitness of the workmen could now prevent the distiller from making use of improved apparatus, which always require more intelligence and more care than those that are less complicated. I doubt not, however, but that in all cases, in which the spirits are to be drawn off at a high strength, or to be corrected by rectification, the distiller would find an advantage in being at the expense of employing intelligent workmen to conduct the process of a better machine. Then the economy in combustibles, and in labour, acquired by such machine would amply indemnify the manufacturer for the higher price occasioned by the employ of more careful and intelligent workmen, particularly if the distillery is of some extent. In other cases, where proof goods are only made, where the wine operated upon is rich, and where taste and flavour are not to be corrected by rectification, in such cases, I say, it might be possible that the distiller would not find the same advantages in making use of improved apparatus, particularly in establishments so small as not to admit of the system of continuity: then a simple condensing apparatus would be sufficient; besides these discussions belong more immediately to the distiller.

The manufacturer having once determined on the choice of the apparatus he means to use, he has only to combine his operations, so as to give to his produce all the qualities requisite for consumption, and to regulate his way of working according to the state of the wine he operates upon.

Thus, each time the distiller wishes to give to his spirit as much of the flavour of the fruit and of the wine as possible, he should not distil it at a stronger degree than is required for consumption. In all other cases, he shall draw the spirit at as high a strength as possible, and if such spirit, lowered with water down to proof, has not quality enough, this proof must again be submitted to the still, to be more concentrated.

This operation will always be practicable with the continuous apparatus, because every thing in this system will tend to favour it. We have seen, in fact, in this system of distillation, that the only difficulty which presented itself some times, was occasioned by the wine being so rich as to be unable to condense its own vapours; for all things equal, the proportion of water should always be greater according as the spirit is to be drawn off at a low strength. But as it is important here to draw the spirit at the highest standard possible, whether one or two, or even three, operations are resorted to, it will be conceived that, with respect to condensation, we shall find here the most favourable circumstances in support of the operation. The contrary would take place, if in operating on too rich a wine, by means of the continuous apparatus, the spirits were only to be drawn at 19° or 22° to preserve all the good quality. Then it is evident that, if water were added to the wine, for the purpose of rendering its distillation possible, it is evident, I say, that the greater the quantity of water that is added, the more obnoxious this addition will be to the quality of the spirits.

If a fermented liquor were distilled by the simple apparatus, and it were necessary to improve the alcohol by the operations of rectification, it is evident that this rectification must be effected by means of passing the spirits repeatedly through the still. Let us suppose, in a similar case, that the first rectification gives part of its products at 30 and some degrees; it would be advantageous to separate this portion of strong spirit from that which runs afterwards at a lower degree. The combustibles necessary for the boiling and vaporization of this alcohol, if it were brought back to the still with the feints, would be saved; in such case, these feints are rectified separately. It is true that, in working in this way, it is necessary not to give over after each operation, but to work continuously, because there is always, at each rectification, a quantity of spirituous liquor left which is too small to make one charge.

In the beet-root sugar-fabric of M. le Duc de Raguse, at *Châtillon-sur-Seine,* where the molasses are submitted to distillation, they nearly work in the way we have just mentioned, and that with the only view of improving the quality of the produce.

The spirit which runs at a strength above 23° or 24°, is separated from that which runs at an inferior degree, and these two productions, separately conducted, form two different qualities proceeding form the same rum, of which that which is obtained at the highest standard and lowered down with water is the best. It must now be easy to account for that variation in quality, which belongs entirely to the influence of rectification. In fact, beet-root molasses contain an essential oil which is disagreeable, or which by its nature favours the formation of empyreumatic oil, in the act of distillation; an acid is thus formed in the fermentation, and these causes of defect in quality, we know, are more or less removed, according as the alcohol is more or less cleared from the water with which it is mixed in the wine. The various substances which might be the object of special distillations are so numerous, and the proportions of alcohol they might render is submitted to such exceptions, and such modifications, that it would be difficult to give an exact and complete index of them.

I am not aware of the residue or spent-wash of fluid matter being applied to any use.

The only substances which it might retain, besides some calcareous salts of little importance, are undecomposed sugar, a gummy substance, and more or less extractive matter.

We have indicated, when treating on fermentation, the process that is to be followed to deprive the spent-wash, as much as possible, of the sugar which it retains, after the first operation, and to effect this to the advantage of the alcohol. This mode, which is only practicable in distilleries, in which the preparation of wine is continuous, would almost leave in the spent-wash the only substances which do not directly concur to the formation of alcohol;—and in general, this spent-wash is wasted on leaving the still. It might, however, be possible to turn it to advantage, in many instances, as manure; and if the acids they retain did not suit the nature of the soil for which they were intended, they might be neutralized by means of lime.

It is a fact that the organical substances which it retains would be most useful to vegetation. It would be necessary to calculate, in such application, whether the effects of such a manure would sufficiently indemnify the farmer, for his expenses in carriage and in labour, which it would occasion.

Section II.

DISTILLATION OF SEMI-FLUID—SEMI-SOLID MATTER.

Wines of a semi-fluid—semi-solid nature may be very numerous, although, in fact, they are less so than fluid wines. The most remarkable, and those which, by their importance, solicit a more particular attention, are lees or ground wines, worts of grain and of potatos, which have not been mashed by extraction. Every means of perfection applied to any of these wines is applicable to all of them, and in this respect we might generalize what we shall say on that subject; but on the other side, there is this difference, that the wines of grain and of potatos may more easily, and with greater advantage, be transformed into fluid wines than lees. This consideration determines us to treat separately on the distillation of these wines, and on the apparatus suitable to them.

LEES.

We have already seen that these wines proceed from the fermentation of the waste of the raisin, such as the stalks, skins, and kernels, with water, either resulting from wine with which they have already fermented, or proceeding from the separation of the must, by means of the press. The fermentable matter, which this waste still contains in this state, particularly when it has already undergone fermentation, is evidently that which has been respected by the press, and which being still enclosed in the cells of the fruit, has thus escaped alcoholic decomposition. This fact again consolidates what we have said on the imperfection of the operation of pressing; and, indeed, if this operation could be executed with the same degree of practical perfection, which we obtain even in a great number of other manufacturing operations, the preparation of *piquette* and of lees-wines, might, without prejudice, be neglected. It is true that, in this case, the distillation of grounds or lees could not be dispensed with; for, admitting even the perfection of the operations of pressing, it would be necessary to separate the alcohol, which the grounds still contain in tolerably large quantities, when, after having fermented with the must, they are separated from it by the press. But, if the difficulty were, thus, not completely removed, it would, at least, be attenuated in many instances.

The difficulty which is attached to the distillation of lees-wines is in the solid substances which they retain in a state of suspension. These substances, which are denser than the wine, precipitate themselves to the bottom of the vessels in which they are deposited; and, if these vessels are stills exposed to the direct action of the fire, they cause them to stick and adhere strongly to the bottom, where they burn and give birth to all the products of the combustion of organical bodies; among which the empyreumatic oil is in large quantities. We are well acquainted with the influence of this oil on spirituous liquors.

Several means have been imagined to prevent this accident. Experience has taught, for instance, that when lees-wines had gained the temperature of ebullition, and when vapour is formed in a continuous manner on the bottom of the still, its rising, occasioned by the ascensive agitation, is an obstacle to the precipitation of solid matter, and of course to their torrefaction. This phenomenon is easily conceived, and I presume it is not in want of being further developed. In consequence of this observation, a vertical bar has been established in the centre of the still, and by these means a chain has been made to sweep the bottom of it. It has, however, been ascertained that this precaution is not always efficacious, and that during the distillation, the workmen might happen to be neglectful in alimenting the furnace, so as to maintain the still in a complete movement of ebullition, the solid matter, not being any longer suspended, precipitates itself to the bottom of the still, and provokes the accident we have just mentioned.

Many authors have proposed the *balnea mariæ* for the distillation of lees; this mode would be good with respect to its effects, if the question of economy would admit it. We have already shown why this system of distillation is really not admissible.

By these means the empyreumatic taste would be avoided, but the taste of the lees which is not caused by torrefaction, as we soon will show, would not be obviated at all.

The heat of steam transmitted through metallic surfaces has also been proposed, but this mode has the same weak sides, with respect to economy, as the *balnea mariæ;* so that we must abandon it entirely.

It would not be the case in the distillation of lees by *mixed vapours;* and this mode is, perhaps, the only one practicable to obtain from lees all the alcohol they can produce, and of preventing, at the same time, torrefaction. It consists in placing the lees in a wooden vessel, but better in a metal one, in which they are to be heated by means of a steam-pipe, similar to that which establishes a communication between the two stills of Adam and Berard. To this effect, a steam-boiler, a still for the lees, a condenser, and a worm would be wanted in a continuous work, the lees would be brought to the boiling point in the condenser, and would offer the advantages attached to this disposition, the number of lees-stills might be increased to two, or even three, by making them of small dimensions, and placing them one above the other, but this would be the utmost of complications, which might, without inconvenience, be adopted in this kind of work. The steam-boiler should be supplied constantly with water, and it must be perceived that, in consequence of this exigence, this system would require, in each operation, the combustibles necessary to boil the water requisite for the distillation of the lees; these lees are rendered poorer when heated, for the vapour of water which fills this function can only produce this effect through its condensation in the mass, by uniting with it until the ebullition commences, when this vapour determines the analysis. It is true that, with three stills, the expenses would not be so considerable; but evidently they would always be supplementary to those which are attached to the distillation of fluid wines by the same process. I thus recommend this mode of distillation to those it concerns, if it were only to deprive the pressed lees, obtained by the means I will indicate, from the alcohol which they retain after the operation of pressing.

If more complicated apparatus were made use of for the purpose of distilling lees, such, for instance, which, like continuous apparatus, force the wine through numerous circulations, before it arrives to ebullition, it would be difficult, not to say impossible, to obtain good results; the solid substances would keep in the angles of the apparatus, obstruct the conduits, and present a vast number of similar difficulties which experience gives us no hopes of removing.

The other mode which has been proposed for the distillation of lees is this:—

It consists in assimilating these wines to those that are perfectly fluid, by first separating, by precipitation, all the liquid they contain, and by submitting the solid residues to the action of an energetic press. This mode would be precious, and free from any objection, if the lees collected in the press did not retain, after this operation, a considerable quantity of alcohol, which could not be well extracted by distillation.

To conceive the cause of this fact, it will be sufficient to consider the mode of acting of organical bodies, charged with water or alcohol: fruits, for instance, that have been preserved in brandy; after a certain time these fruits imbibe the alcohol of the brandy, and emit the water. The cause of this phenomenon is not well known, but the fact exists, and has, no doubt, attracted the notice of the reader. In fact, fruits preserved in alcohol have always a greater alcoholic taste than the liquor in which they have been preserved; this has been the cause of its being commonly said that fruits drink spirits.

The same phenomenon takes place in all wines which have fermented with solid substances; these contain always more alcohol, in proportion to their weight and volume, than the liquid in which they are found. When the solid substances of the lees are merely separated by the press, the production of spirits is considerably lessened, by not submitting to distillation the substances which retain the alcohol in the greatest proportion: this fact has been verified by comparative experiments on grain and on potatos. On the other side, the spirit thus produced gains much in quality, and the cause of this acquisition is easily explained by the results of Mr. Aubergier's inquiries on that subject. The distillation of the skins of the raisin, in which the essential oil is seated, which gives the lees taste, properly speaking, is, in fact, avoided by these means.

Thus it would be necessary, in the choice of the method to be followed in the distillation of lees, to discuss whether, on one side, the acquisition of quality obtained, with the loss of a certain portion of alcohol, is not more advantageous to the interests of the distiller than to obtain the whole of the alcohol, subject to the infectious taste of the lees, of empyreuma, and, moreover, with the danger of all the difficulties attached to the distillation of semi-fluid semi-solid substances.

I firmly believe that the first of these two propositions unites the most causes in its favour; and this opinion is the better founded, as it may be possible, by adopting the method which it embraces, to remove the only weak side it presents.

In fact, let us suppose a given quantity of lees transformed into fluid wines by separating the solid substances by means of the press. The fluid matter should first be distilled by the same apparatus and the same processes as wine, in the class of which these operations would thus place it; and, moreover, the solid substances might be distilled by means of the steam of water, with the disposition which I have recommended as useful in treating lees.

Two qualities of spirits would thus be obtained, one of which would scarcely differ from that of fluid wines, and the other bearing all the taste of the lees, of which it might be freed by rectification.

I think this mode conciliates sufficiently the chances of success to attract the attention of lees' distillers, and is in perfect harmony with the principles we have professed.

As to the recommendation which has been

made to saturate the acid of the lees with chalk, I believe it to be good; but I think that the use of chalk is at an end there, and does not in the least contribute to neutralize the essential oil.

The solid substances of lees, when dried and burned, give a produce which is called *lees' ashes;* this operation is a true incineration, the products of which are gathered. Among these products, which are all of a calcareous nature, the tartrate acid of potash is found in large quantities, and it is to this body, useful to the arts, that lees-ashes owe their value.

Very often the residues of the distillation of lees are used as manure, and this agent of reproduction is tolerably appreciated in the vineyards. It is, in fact, a true consumption in the place of production, which assigns to this mode of working all the advantages which it offers to science and to agricultural practice.

We will conclude this article by giving an extract made by Mr. Gay Lussac, out of a memorial of Mr. Aubergier, on the spirits of lees. This extract, which is inserted in the *Annales de Chymie et de Physique*, tom. xiv. page 210, will give further information on what I have said in this chapter, concerning the special distillation of lees:—

" It had been thought, until this day, that the flavour, and the acid and penetrating taste of lees-brandies, were owing to a certain oil, which, according to some, was formed during the process of distillation, and, according to others, existed already formed in the kernels of the raisins. According to the observations of Mr. Aubergier, it would appear that this oil is seated in the skin of the raisin itself, and from the facts which he relates, his opinion is likely to be true.

" Kernels distilled with alcohol or water have given a liquor of an agreeable taste. The stalks have produced, by distillation, a liquor slightly alcoholized, having neither the taste nor the flavour of lees-brandy.

" But the envelope of the raisin, separated from the kernels and from the stalks, when submitted to distillation, after having been fermented, have given a spirit in all respects similar to that of lees.

" Thus it appears clearly demonstrated by these experiments that the seat of the oil, which communicates to the lees-brandy its bad qualities, is in the skin of the raisin.

" Mr. Aubergier has succeeded in obtaining this oil by rectifying lees-spirit at a moderate heat. The first portions of alcohol which came over had much less acrity than those that followed: on having been rectified a second time, they were almost entirely free from it; however, repeated rectifications could not give it so agreeable a taste as that possessed by the spirit produced from wine.

" The latter portions of liquid in each operation, reunited and distilled, gave, at first, alcohol which the addition of water did not render troubled, and which contained but little oil. The portions which were afterwards obtained were transparent, but they became troubled when mixed with water: the third portion, which remained milky until the end of the operation, had on its face a light couch of oil, although it marked 23° Beaumé.

" This last produce having been mixed to the second, and a suitable quantity of water having been added, to bring them down to 15°, the liquor became immediately opacous, and a quarter of an hour after, it was covered with a quantity of oil: one hundred and fifty litres have produced more than thirty grammes of this oil.

" This oil has the following characteristics:

" It is extremely limpid and colourless the moment it is separated from the alcohol, but the light gives it, a few moments after, a slight lemon colour. It is very fluid; its flavour is penetrating and its taste very acrid and disagreeable. Submitted to distillation, the first portions that are volatilized keep their aroma; but the product soon acquires an empyreumatic taste, which Mr. Aubergier suspects, is caused by a small portion of fixed oil proper to the kernel of the raisin;* the liquor left in the retort takes at the same time the colour of lemon, which increases during the operations, and leaves at last a very light coal. It combines with water in the proportion of one thousandth part, and gives to it its flavour and acrity. When in ebullition it dissolves sulphur, which is precipitated by cooling, and, with alkalis, it forms soap. This oil is so penetrating and so acrid that one drop of it is sufficient to infect 100 litres of the best brandy.

" Mr. Aubergier remarks that the spirits that are drawn from the various fruits owe their particular taste and flavour to a volatile and oily principle, generally found in the surface of each fruit, and that by taking this surface away they would almost all be alike: that by thus depriving apples, pears, plums, apricots, peaches, and even barley, of their envelope, spirits would be drawn from these vegetables almost entirely free from the flavour inherent to them."†

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* " It is not necessary, to explain this fact, to resort to the presence of a fixed oil in that which is drawn from lees-spirit; for the latter, although it has a very acrid taste and flavour, is, nevertheless, much less volatile than essential oils."—*Note of Mr. Gay Lussac*

† " Many persons attribute the taste and flavour of lees-spirit to distillation itself, during which the lees stick to the

SEMI-FLUID, SEMI-SOLID WINES OF CORN AND OF POTATOS.

Every thing I have said on the special distillation of lees, and on the apparatus suitable to it, is also applicable to the wines or worts of potatos and of grain.

To this case are again attached all the inconveniences attending its application to the distillation of lees. In fact, the dangers of torrefaction depend, in this case, on the workmen, which is not a sufficient guarantee for their disappearance, and they may often be reproduced. The taste of empyreuma exists thus always more or less

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sides of the stills, which causes them to be carbonized. One thing which confirms the influence of this fact is that, when lees are distilled by the new process, that is by the steam of water, spirits of a much better quality are obtained. However, it is not less certain that lees-spirits contain a peculiar essential oil, odorous, very acrid, altering their quality very much, and on which Mr. Aubergeir has made interesting remarks.

This oil, by its flavour, its acrity, and its property of not staining paper, and of not being converted into soap by alkalis, must be classed among the number of essential oils; but its property of being little soluble in alcohol, of burning without smoke, and of being much less volatile than the rest of essential oils, which I have verified on the sample obtained by Mr. Auburgier, prove that it has some analogy with fat oils."—*Note of Mr. Gay Lussac.*

intensely in spirituous products, and these retain besides the bad taste and flavour of the fruits. In fact, it would appear as if these peculiar and distinctive variations did belong to an essential oil, which must principally reside in the husks of the grain and of the potatos, and which is still incorporated in the spirituous produce, more or less intensely, according as those substances have been introduced in smaller or larger quantities in the fermentation and distillation. Thus, it may be conceived that the most efficacious correcting mode is that which we have already recommended, and which consists in fermenting nothing but very fluid extracts.

It is not my object, in this discussion, to introduce innovations prejudicial to the established mode of working of distilleries, which could not adopt them, without injuring their interests; my only task is to signalize the causes of the different qualities of spirits, and the means of conquering them.

The condensing apparatus, already mentioned, is that which is most generally made use of in the distillation of corn and of potatos.

It would be very useful to a manufacturer who wished to establish a corn or potato distillery, in a country where a good quality of brandy is consumed, it would be useful, I say, to proceed in such a way as to give to the produce the least taste of those vegetables possible; the object of working in this way would not be to identify the new liquor with that which is known and preferred, but it would be at least making a great step towards it. The experience of the Parisian distillers is an instance of this case.

In countries where large quantities of corn and potato spirits are distilled, some sort of essential oil is always incorporated with the liquor, which masks, if not the tastes, at least the peculiar flavours which the fruits and the various processes of distillation give to the produce. The essential oil which is most generally used is that of juniper berries, it is mixed in the still with the low wines, in smaller or larger proportions, according as the spirituous produce is to have a weaker or stronger taste of it. This causes the corn spirit, of which so large a quantity is consumed in Belgium and in the north of France, to be called by the name of *Geneva*; this name is given to the spirit, even when it does not possess any aromatic flavour at all.

Instead of the juniper berry they often use other odorous substances, such as anis, wild oranges, &c. which are mixed with the low wines, in the last rectification. Similar means would thus contribute to give less utility to the various operations, tending to improve the quality of the spirits.

The distillation of grain and of potatos is often combined with the feeding of cattle; and if, in some towns, there exist distilleries that do not dispose of their spent-wash in that way, it is because they can sell it to feeders, who in general hold it in great esteem. Cattle are very fond of it, it nourishes well, and keeps them in a good state of health, but to use it as a powerful means of producing flesh, it should be mixed with linseed cake, which makes the spent-wash a very effectual food. Oxen may, by these means, be well fed in the space of three months.

THEORY OF DISTILLATION.

A friend of mine, as zealous for the progress of the useful arts as he is enlightened and modest, has endeavoured to submit to algebraical formulas the theory of the analysis of wine by distillation. He has not given me his work, as a precise theory which future experiments might not modify, but simply as an exercise in calculations, the results of which are founded on likely hypotheses, and which do not appear to secede from reality. Well convinced of the utility of investigating the exact sciences in the domain of chemical arts, I have thought that his production, although scientific, would be a complement necessary to the empirical notions which I have already given on the theory of the analysis of wine. This is his work, such as it has been communicated to me.

" The object of distillation is to separate one or several liquids mixed or combined together, but the combination of which ceases as soon as they enter into vapour. It is founded on this principle, that when a body is susceptible of combining with two other bodies, taken separately, but the combination of which with the one forms an obstacle to its combination with the other, if those bodies are placed in contact, so as to allow the combination to take place, the double combination will only be stable when the affinities equilibrate reciprocally. Thus I suppose that, at a given temperature, the steam or vapour of A may be dissolved in the unit space, until it supports the pressure ϖ, and the vapour of A′, until it is submitted to the pressure ϖ'. If the pressure which the mixture of vapours can undergo is unlimited, and that A and A′ are in sufficient quantities, the pressure Π, which exists when vaporization ceases, is equal to $\varpi + \varpi'$. But if this pressure be limited, and if it cannot be superior to Π, vaporization only ceases when $\varpi_, + \varpi_,' = \Pi$, and when $\frac{\varpi}{\varpi_,} = \frac{\varpi'}{\varpi'_,}$. In fact, the affinity of space for any vapour is in direct proportion with the quantity of vapour it can dissolve, and in inverse proportion with the quantity already dissolved; and as this quantity is proportionate to the tension which results from it, the affinity which the space still retains for the vapour of A may be represented by $\frac{\varpi}{\varpi_{,}}$, and that which it retains for the vapour of A′ by $\frac{\varpi'}{\varpi'_{,}}$ Now, to make vaporization cease, it is necessary those two affinities should equilibrate, thus it is necessary that $\frac{\varpi}{\varpi_{,}} = \frac{\varpi'}{\varpi'_{,}}$. Such is the condition we have established.

Not to intricate my reasonings by signs, the value of which would not be well established, I will proceed to give the designation of those I shall have to employ :—

	Liquid A.	Liquid A′.	Mixture of the two Liquids.
Density........	$= D$	$= D'$	$= D_{,}$.
Proportion in the liquid mixture.	$= P$	$= P'$	
Specific heat...	$= C$	$= C'$	$= C_{,}$.
Temperature of ebullition....	$= T$	$= T'$	$= T_{,}$.
Heat absorbed by the vapour to pass from 0° liquid to the aeriform state.	$= N$	$= N'$	

	Liquid A.	Liquid A′.
Maximum of tension for the temperature t.	$= F_t$	$= F'_t$
Any tension at the temperature t.	$= f_t$.	$= f'_t$.
Density of the vapour at 100°* and $0^m,76$ pressure brought back to 0°....	$= d$	$= d'$
Density of the vapour at t degrees........	$= \delta_t$	$= \delta'_t$

Expense in heat for one mode of distillation	m
Quantity of refrigerating liquid necessary for this mode........................	ϖ
Specific heat of this refrigerating liquid....	χ
Relative value of the unit of heat and the unit of the refrigerating liquid.........	γ
Total expense expressed in units of heat...	M

To express the maximum of the tension of the vapour of A, at any temperature t, we have the formula

$$\text{Log } F, = 1{,}8808201 - 0{,}015372728757n - 0{,}00006731995n^2 + 0{,}00000003374n^3 \text{(A)}.$$

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* Centigrade thermometer.

In which $n = T - t$. The same formula would give the maximum of the tension of the vapour of A′. Any tension f in function of the temperature and of the density may be expressed by the formula

$$ft = 0^{m},76(1 + t\ 0,00375)\frac{\delta_t}{d}\ (B).$$

These two formulas, which will be useful to us hereafter, being demonstrated in the *Traité de Physique* of Mr. Biot, it will be sufficient to mention them.

When two liquids are combined in such a manner, that their respective properties are not destroyed, as is the case in liquids submitted to distillation, the density D of the mixture is the mean term between the densities of the two componing liquids; it may thus be represented by $D_{,} = \frac{DP + D'P'}{P + P'}$ (1). It is the same with the specific heat, which is obtained by means of the formula $C_{,} = \frac{CP + C'P'}{P + P'}$ (2), and with the temperature of ebullition of the mixture, which is given by the formula $T_{,} = \frac{TCP + T'C'P'}{CP + C'P'}$ (3), formula which indicates that the mixture enters into ebullition when it contains the same quantity of heat that would be necessary to P parts of A and to P′ parts of A′, to boil separately.

This being posed, let us examine that part which is relative to distillation; the latter offers three distinct cases, viz.; 1st. that in which the mixture is submitted to a tumultuous ebullition, in which the vapour is collected as soon as it is disengaged, in a close vessel, wherein it is cooled; 2d. that in which the vapour, after its formation, is placed into contact with the liquid from which it proceeds, maintained at the temperature of ebullition; 3d. that which, after its formation, is placed into contact with the liquid mixture, having a temperature below that of ebullition.

Let us examine the first case, in which the vapour is collected, in a closed vessel, as soon as it is formed.

At the moment of its formation, its temperature is equal to $T_,$ which is suitable to bring the liquid, in which it has been formed, to ebullition; this temperature is thus known by the formula

$$T_, = \frac{TCP + T'C'P'}{CP + C'P'}.$$

It equilibrates with the atmospherical pressure p, and the density of the partial vapours is proportionate to the simple liquids from which they spring; for the liquids A and A′ are of such nature as to remain in a state of combination as long as they are not vaporized. This gives the means of determining which is the tension supported by each of these vapours, and also their respective densities; in fact, we have in virtue of formula (B)

$$f_{T_{\prime}} = 0^m,76\,(1 + T_{\prime}0,00375)\frac{\delta_{T_{\prime}}}{d}$$

$$f'_{T_{\prime}} = 0^m,76\,(1 + T_{\prime}0,00375)\frac{\delta_{T_{\prime}}}{d'}$$

which, added to

$$f_{T_{\prime}} + f'_{T} = p \text{ and } \frac{\delta_{T_{\prime}}}{\delta'_{T_{\prime}}} = \frac{P}{P'}$$

give by eliminating the following equations, which indicate the tensions and densities of each of the two vapours:

$$f_{T'} = p\frac{Pd'}{Pd' + P'd};\quad f'_{\prime} = p\frac{P'd}{Pd' + P_{\prime}d};$$

$$\delta_{T_{\prime}} = \frac{pd}{0,76\,(1 + T_{\prime}\,0,00375)}\;\frac{P'd}{(Pd' + P'd)};$$

$$\delta'_{T_{\prime}} = \frac{pd'}{0,76\,(1 + T_{\prime}\,0,00375)}\;\frac{P'd}{(Pd' + P'd)}.$$

Let it then be cooled in a close vessel, and let the temperature be brought down to t. The maximum of the tension of A, at this temperature, is obtained by the formula (A), from which derives $\delta_t = \frac{F_t d}{0,76\,(1 + t\,0,00375)}$.

If it is only necessary to lower the temperature to the point at which the vapour of A would begin to be condensed, it is requisite that $\delta_t = \delta_{T_{,}}$ be accomplished, thus

$$\frac{F_t d}{0{,}76(1+t\,0{,}00375)} = \frac{pd}{0{,}76(1+T_{,}0{,}00375)}\ \frac{Pd}{(Pd'+P'd)},$$

equation, the second number of which is entirely known. A value proper to establish the equation is now to be given to t; this cannot be obtained in a direct way, for F_t is given in function of t by a transcendent expression, but we can find in an indirect manner.

t being once determined, we may ascertain which is the density δ'_t of the vapour of A′ by means of the formula $\delta'_t = \dfrac{F'_t d'}{0{,}76\,(1+t\,0{,}00375)}$ which is the same as (B), in which F'_t is obtained by the formula (A).

Thus there exists between δ_t and δ' the following proportion $\dfrac{\delta_t}{\delta'_t} = \dfrac{F}{F'_t d'}$; such is also the proportion of A and of A′, in the produce, if the vapour is then collected to be condensed.

We may also determine the temperature t in such a way as to cause the produce to contain determined proportions of A and of A′; be $\dfrac{P}{P_{,}}$ this proportion, it is necessary that $\dfrac{\delta_t}{\delta'_t} = \dfrac{P}{P_{,}}$, or that $\delta_t = \dfrac{P}{P'}\,\delta'_t$.

This value of δt substituted in the formula (B) gives

$$f'_t = 0{,}76(1+t\,0{,}00375)\frac{P}{P_{,}}\,\frac{\delta' t}{d}\,;$$

$$f'_t = 0{,}76(1+t\,0{,}00375)\frac{\delta'_t}{d'}\,;$$

which divided, one by the other, give

$$\frac{ft}{f't} = \frac{d'}{d}\,\frac{P}{P_{,}}$$

As one of the vapours has necessarily been already condensed, for this one the tension must be at its maximum, with respect to temperature. Thus, if it be A′, which has already been condensed, we have $f'_t = F'_t$. If the vapour of A has not yet undergone condensation, its density is unaltered, thus it is expressed by the formula

$$\delta_t = \delta T_{,} = \frac{pd'}{0{,}76\,(1+T_{,}0{,}00375)}\,\frac{Pd'}{(Pd'+P'd)},$$

and the proportion $\frac{ft}{f't}$ gives the following:

$$\frac{ft}{f't} = \frac{ft}{F'_t} = \frac{d'}{d}\,\frac{P}{P_{,}}\,;$$

and as

$$f_t = 0{,}76(1+t\,0{,}00375)\,\frac{\delta_t}{d}$$

$$= \frac{0{,}76(1+t\,0{,}00375)}{0{,}76(1+T_{,}0{,}00375)}\,\frac{Pd'}{(Pd'+P'd)}\,p,$$

this proportion becomes

$$\frac{(1+t\,0{,}00375)}{(1+T_{,}0{,}00375)}\,\frac{Pd'}{(Pd'+P'd)}\,\frac{p}{F'_t} = \frac{d'}{d}\,\frac{P}{P_{,}},$$

from whence

$$\frac{F'_t}{(1+t\,0{,}00375)}=\frac{Pd'}{(Pd'+P'd)}\,\frac{p}{(1+T_{,}0{,}00375)}\,\frac{d}{d'}\,\frac{P}{P_{,}},$$

equation, in which the second member is completely known. We have now to determine the value of t in such a manner as to fulfil the equation, which can only be done in an indirect way.

If the vapour of A and that of A′ were already partly condensed, each of those vapours would have the maximum of tension, and the formula $\frac{ft}{f't}=\frac{d'}{d}\,\frac{P}{P_{,}}$ would become $\frac{F_t}{F'_t}=\frac{d'}{d_{,}}\,\frac{P}{P_{,}}$, which would become satisfied by the value given to t; but it is not suitable, in any case whatever, to bring the temperature so low; thus we must only direct our attention to the two preceding cases, to determine what expense this mode of distillation requires: it is necessary to examine how many units of heat it requires, and what quantity of refrigerating liquid is wanted.

As the liquid mixture is to be entirely vapourized, we have

$$m=NP+N'P'.$$

Supposing the portion of A′, which is condensed before it is collected, to be disengaged at t temperature, the refrigerating liquid to be disengaged at the same temperature, and the produce to be received at 0° temperature, which I suppose to be that of the refrigerating liquid, the moment it is introduced into the apparatus, the quantity of refrigerating liquid necessary in case the temperature is only lowered down to the point at which no part of A has yet been condensed, is expressed by

$$\varpi=\frac{(P'-P_{,})\ (N'-C't)+N'P_{,}+NP}{\chi t};$$

$\varpi\chi t$ expressing the number of units of heat absorbed by the refrigerating liquid: according to our calculation, ϖ may be expressed in units of heat, by

$$\pi\gamma=\gamma\frac{(P'-P_{,})\ N'-C't)+N'P_{,}+NP}{\chi t}.$$

The whole expense may thus be expressed by

$$M=m+\varpi\gamma=NP+N'P'+\gamma\frac{(P'-P_{,})(N'-C't)+N'P_{,}+NP}{\chi t}$$

Let us now see what takes place in the second case, in which the vapour, after its formation, remains in contact with the liquid mixture from which it proceeds, having the same temperature T*t*. After the formation of the vapour composed of the same proportions of A and of A′ as the liquid mixture, if the space which it occupies has greater affinity for the vapour of A than for the vapour of A′, a portion of the latter is condensed, and cedes its heat to a corresponding portion of the liquid mixture which is volatilized. This exchange takes place as long as the affinities of the space for the vapour of A and for that of

A′ are not counterbalanced; but for a contact suitably protracted, we would obtain the proportion $\frac{f\mathrm{T}_,}{f'\mathrm{T}_,}=\frac{\mathrm{FT}'}{\mathrm{F}'\mathrm{T}_,}$ and $f\mathrm{T}_,+f'\mathrm{T}=p$ between the tension $f\mathrm{T}_,$ of A and the tension $f'\mathrm{T}_,$ of A′.

These two equations added to the equations (B) lead to $\frac{\delta\mathrm{T}}{\delta'\mathrm{T}_,}=\frac{d}{d'}\,\frac{\mathrm{FT}_,}{\mathrm{F}'\mathrm{T}_,}$ which determines the proportions of A, and of A′ in the produce, proportions to which we could not arrive, unless by an indefinite protraction of the contact; thus this proportion is a limit to which we approach the more, according as the contact is more protracted, but which cannot, rigorously speaking, be attained.

To determine what expense this mode of distillation occasions, it is necessary to observe that $m=(\mathrm{P}'-\mathrm{P}_,)\,\mathrm{C}'\mathrm{T}_,+\mathrm{N}'\mathrm{P}_,+\mathrm{NP}$, for a quantity P of the liquid A, and a quantity $\mathrm{P}_,$ of the liquid A′ are to be vaporized and $\mathrm{P}'-\mathrm{P}$ remaining part of the liquid A′ is to be brought to ebullition. The refrigerating liquid must condense the vapour, and supposing it be allowed to disengage itself when it has attained the temperature *t*, it becomes

$$\frac{\mathrm{N}'\mathrm{P}_,+\mathrm{NP}}{\chi^t}=\varpi,\ \text{from whence}\ \varpi\gamma+\gamma\ \frac{\mathrm{N}'\mathrm{P}_,+\mathrm{NP}}{\chi^t}$$

and in consequence

$$\mathrm{M}=m+\varpi\gamma=(\mathrm{P}'-\mathrm{P}_,)\mathrm{C}'\mathrm{T}_,+\mathrm{N}'\mathrm{P}'+\mathrm{NP}+\gamma\frac{\mathrm{N}'\mathrm{P}_,+\mathrm{NP}}{\chi^t}.$$

Let us, finally, examine what takes place in the third and last case, that in which the vapour, after it has been formed, is placed in contact with the liquid from which it proceeds, having a temperature below $T_,$.

Supposing t to be the temperature of the liquid with which the vapour is placed in contact at the moment it is received, we have again, as in the preceding case, $\frac{f_t}{f'_t}=\frac{F_t}{F'_t}$, equation which, added to the formulas (B), would give $\frac{\delta_t}{\delta'_t}=\frac{d}{d'}\frac{F_t}{F'_t}$, limit of the proportion of A and of A′ in the produce, to express the expense occasioned in this instance. It must be observed that it is only necessary, in this case, to bring to ebullition that part which is not received, and that no condensing liquid is made use of; thus we have $m=M=(P'-P_,)C'T_,$.

Such are the various questions that may be proposed on distillation; all the cases of which are contained in the three we have just examined, or are only a complication of them.

Degrees of the Scale of Cartier compared to the Specific Gravities of Spirituous Liquors.

Scale of Cartier.	Specific Gravity.	Scale of Cartier.	Specific Gravity.	Scale of Cartier.	Specific Gravity.
	Water.				
10	1000	22°	914	34°	837
11	1000	23	907	35	831
12	990	24	900	36	825
13	981	25	893	37	820
14	973	26	886	38	814
15	965	27	880	39	808
16	958	28	873	40	802
17	950	29	867	41	797
18	943	30	861	42	792
19	935	31	855	Pure Alcohol.	
20	923	32	848		
21	921	33	842		

Degrees of Beaumé's Areometer, or Saccharometer, compared to the Specific Gravities of Worts and Saccharine Dissolutions.

Scale of Beaume.	Specific Gravity.	Scale of Beaume.	Specific Gravity.	Scale of Beaume.	Specific Gravity.
0	1000	18	1140	36	1324
1	1006	19	1148	37	1336
2	1013	20	1157	38	1349
3	1020	21	1167	39	1361
4	1028	22	1176	40	1374
5	1035	23	1186	41	1386
6	1042	24	1195	42	1400
7	1050	25	1205	43	1413
8	1058	26	1215	44	1427
9	1065	27	1225	45	1441
10	1073	28	1235	46	1456
11	1081	29	1246	47	1470
12	1090	30	1256	48	1485
13	1100	31	1267	49	1500
14	1106	32	1278	50	1515
15	1114	33	1289		
16	1125	34	1301		
17	1132	35	1312		

100 Pounds avoirdupois = 44,54 kilogrammes.

1 Gramme = $\frac{1}{1000}$ of a kilogramme.

1 Hectolitre = to 100 litres.

4,52 Litres = to 1 imperial gallon.

1 Metre = 100 centimetres = 1000 millimetres.

304,8 Millimetres = to 1 English foot.

For the reduction of the degrees of Reaumur's thermometer into degrees of Farenheit, see Distiller's Guide, page 82.

INDEX.

A.

Acids, considered as the causes of the various tastes and flavours of spirituous liquors, 472.
Areometry, art of, xiv. 524.
Air, fixed, Mr. Lavoisier on, 130.
—— atmospherical, 428.
—— Mr. Gay Lussac's experiment on, 429.
—— action of, in the vinous fermentation, 429.
———— in the acetous fermentation, 431.
Alcohol, its nature, properties, 136, 413.
——— identic in all spirituous liquors, 462.
Alembic, a small, for the trial of wines, 87, 91.
Alembics, 41, 44.
Ambergris, essence of, to make, 265, 266.
——— compound essence of, 267.
Aniseed Cordial, to make, 210.
Antiscorbutic Water, 260.
Apparatus, distilling, 436.
——— continuous, of Mr. Derosne, 437.
————— of Mr. Cellier Blumenthal, 451.
————— of Mr. Baglioni, 456; comparison between Mr. Derosne's and Mr. Berard's.
Auxiliary Agents, of some, 393.
Aromatic Cephalic Water, to make, 269.

B.

Balm Water, or Eau de Carmes, to make, 270.
Balsamum Vitæ, to make, 270.
Bate's Saccharometer, 103.
Beaumé's Saccharometer, 524.
Beauty Water, or Eau de Beauté, to make, 265.

Beet Root, 300.
——— contains saccharine matter, 301.
——— choice of, for Distillation, 302.
——— Molasses of, 308.
——— method of preparing for fermentation followed by Mr. Cafler, 309.
——— ditto ditto by Mr. M. de Dombasle, 312.
Bitters, to make, 205.
Black, Dr., experiment by, 19.
Blebs, what, 117.
Boilers and Condensers, improvements in, 67.
Brandies, French, 132, 137.
——— British, how to make, 192.
——— Lees, 496.
Brandy Shrub, to make, 208.

C.

Caloric, its nature, 78, 79.
——— important part acted by, in the vinous fermentation, 420.
——— degree of, to be given to fermenting liquids to be fixed according to their bulk, 421.
——— produced by fermentation, 422.
Capillaire, 248.
Carraway Cordial, 211.
Cardamom Cordial, 254.
Cellar, a good, how to choose, 109.
Cellars, construction of good, 110.
Chaptal, M., description of a Distillery from, 107.
Cherry Brandy, to make, 220.
Cinnamon Cordial, to make, 211.
——— strong, 251.
——— Water, simple, 244.
Citron Cordial, to make, 212.
Civet, how produced, 268.
Clarke's Boilers, 67, 68.
Compounds prepared without Distillation, 206.
——— or Cordials, to make, 249.
Cooler or Refrigerator, 75.
Corn, 322.
——— which is the most proper for Distillation, 322.
——— choice of, 323.
——— grinding of, 324.
——— malting of, 332.
——— steeping of, 333.
——— malting of, properly speaking, 334.
——— drying of, 338.
Cucurbite, the, 44.

D.

Damask Rose Water, 245, 246.
Deurbrouck, M., improvements by, 61, 65.
Dicas's Instrument, 97, 102.
Distillation, art of, not abstruse, iv.
———— improvements in, v.
———— of Wines, origin of, ix.
———— Mr. Adams' Theory of, xv.
———— Authors who have treated upon, xi.
———— first mode of, xii.
———— in vacuo, xiii.
———— Wines proper for, xiv.
———— by various processes, 19, 20.
———— Apparatus used for, in Great Britain, 40.
———— Theory of, 511.
———— influence of, on the tastes and flavours of spirits, 475.
———— on Special, 488.
———— of semi-fluid semi-solid matter, 496.
Distilled Spirituous Waters, 257.
Distiller, general directions to the, iii.
———— Art of the, expressed in a Problem, iv.
Distillery, on the best principles, description of, 107.
———— Perfection of the Art in France, 436.
Distilleries, improvement in, a curious, suggested by Mr. Birch, 72, 73.
Distilling, Apparatus for, xvii.
Distillery in Scotland, method of, 65.
Doubling, what, 77.

E.

Eau de Luce, to make, 218.
Egg Plate, explanation of, 26, 38.
Eggs, Vessels in the form of, 24, 25.
Elder Juice, 222.
Elixir, Sweet, of Vitriol, 271.
Ether, to make, 194, 196.

F.

Faints, what, 79.
Fermentation, Vinous, 233, 404.
———— imperceptible, 233, 406.
———— conditions of, 409.
———— effects of, 234.
———— phenomena attendant on, 134.
Flavouring Spirits, 202.
Foreshot, what, 77.

French Brandy, colour of, 132.
——— how preserved, 132.
French method of making Wines.

G.

Gentian Water, compound, 256.
Gin Bitters, to make, 205.
Glossary, a, 329.
Goods, how to recover, 121, 122.
——— how to dulcify and fine, 124.
Gout Water, to make, 264.

H.

Heat, inequality of, in distilling, how to prevent, 91.
Hungary Water, 252.
Hydrometers and Saccharometers now in use, 97.

J.

Jamaica Pepper Water, 256.
Jessamine Water, 259, 260.
Juniper Berries, the use of, 203.

K.

Kiln, the Flemish, 85.
——— advantages of, 86.

L.

Lavender Water, simple, 253.
——— compound, 253.
Leaven, 396, 403.
Lemon Water, 259.
Lime Water, 193.
Liqueur, la bonne Vespetro, 228.
Lob, the mixture so called, 111, 112.
Lovage Cordial, 214.
Low Wine, 131.
Luting, how to make, 120.

M.

Malting, as connected with the Distillery, 127.
——— practice of, in Scotland, 128, 332, 333, 334, 338.

Malt distilling, 142.
Mixing of Spirits, mode of, 284, 286, 485.
Molasses Spirits, 138, 284, 286, 296.
——— Colonial, 297.
——— Sugar Boilers, 300.
Musk, properties of, 267.
—— Essence of, to make, 268.
Must, 231, 232, 233.

N.

Nectar, to make, 215.
Nitre, dulcified Spirit of, 197, 198.
Noyau, to make, 210.

O.

Orange Flower Water, 248.
——— Peel Water, *ib.*
——— Wine, *ib.*

P.

Pennyroyal Water, 245.
Peppermint Cordial, to make, 208, 209.
——— Water, simple, 244.
Perrier, Sir Anthony, improvements by, 33, 60.
Plague Water, to make, 261.
Potatoes prepared for Distillation by malted Barley, 361.
——— boiling of, *ib.*
——— reduction of, 367.
——— mashing of, 369.
——— prepared for Distillation by means of Sulphuric Acid, 382.
Proof, artificial, to make, 193.
—— Spirits, total of, collected, 281.

R.

Raspberry Brandy, 221.
Ratafia Imperial, to make, 212.
Rectification, how performed, 139.
——— of low wines, 140.
——— considered as the means of correcting the tastes and flavours of Spirituous Liquors, 481—488.
Rectified Spirit of Wine, 199.
Rectifiers, what, 116.
——— Stock, method of casting a, 280.
Redistillation, an elegant process for, 21.

Repasses, or feints, 35.
Retorts, 41.
Roserea, improvements at, 73, 74.
Rosemary Water, to make, 242.
Rules, general, for calculating any Spirit, 282.
Rum, how manufactured in the West-Indies, 188, 297—300.
—— Shrub, Recipe for making, 206, 207.

S.

Saccharometers and Hydrometers now in use, 97.
Scurvy Grass, uses of, 260.
Sea Water, property of, 81.
Shrubs, various, 206, 208.
Simple Distilled Waters, 243.
————————, general rules for the distillation of, 239.
—— alexiterial water, *ib.*
Spearmint Water, 247, 248.
Spicy spirit, to make, 214.
Spirits, a flavourless, 204.
——, vinous, proper use of, 201.
——, their strength, 104, 105.
——, on the flavouring of, 202.
——, the best way of trying, 117, 122.
——, manner of mixing, 284.
Spirituous tinctures, or infusions, 223.
—— liquors, unhappy tendency of, 200.
Still, a, 41.
——, Mr. Wright's, 49.
——, the particular, required in England, 112.
——, advantages of a small, 116.
——, the cold, best adapted for simples, 241.
Stills, the English, and their improvements, 46.
——, the, used in Scotland, France, Flanders, and Holland, 70.
——, made of copper, 74.
——, general description of, 75.
—— used for simple waters, 240.
Surfeit Water, 262.
Sykes's hydrometer, 97, 99.

T.

Temperature and quality of spirits, how distinguishable, 104.
Tennant, Mr. Smithson, memoir by, 78, 80, 82.
Thermometers, different, 82, 83.
Tincture, bitter, 227.
Tinctures and Infusions, 223.
————, general rules for extracting, 225.
Tritton, Mr. Henry, apparatus by, 20.

V.

Vinegar, mode of making at Paris, 235.
————, English, 236.
———— at Orleans, 432.
Vinous Spirits, their uses, 201.
Vitriolic Liquor, to make, 194, 196.
Vitriol, sweet elixir of, to make, 271.

U.

Usquebaugh, to make, 215, 216.
—————, royal, 217.

W.

Water most proper for distillation, 83, 84, 393—396.
——— of the four spices, 262.
——— for the stone and gravel, 263.
Waters, common or genevas, how to recover, 121.
————, simple, general rules for distilling, 239.
————, simple, distilled, 243, 248.
————, spirituous, general rules for the distillation of, 257, 258.
Wine, rectified spirit of, 199.
Wines, how preserved in France, 110.
———, the French method of making, 230.
Worm-tubs, 42, 43.
Worm-wood cordial, 218, 219.
Woulfes' apparatus, 46.
——————————, simple form of, 67.
Wright, Mr., still invented by, 48, 49.

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